Drawing development in autistic versus non-autistic children.

Lord-Rees, Elen

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By Elen Lord-Rees

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Contents

Summary

The present study examined the relations between intellectual maturity and drawing realism in autistic children, developmentally normal children, and Down's syndrome children. Intellectual maturity was assessed using tests of verbal age (the British Picture Vocabulary Scale), non-verbal age (Raven's Coloured Progressive Matrices), the understanding of false belief (the Sally-Ann test) and, for the clinical groups, central coherence (the Block Design subtest of the WISC). Children were confronted with a series of objects to draw, namely, a striped mug, a teapot with a decorative pattern above its spout, a cup and saucer, and a cup with artificial flowers placed inside it. In all cases, the model was positioned such that its handle was hidden from sight and children were asked to produce a view-specific depiction. Drawing realism was evaluated in terms of children's ability to avoid a commission error for the occluded handle (all four tasks), their portrayal of visible decorative features (the stripes on the mug and the pattern on the teapot), and their portrayal of contextual details (the saucer and the flowers). Participants additionally completed the Goodenough-Harris Draw-A-Person test (Harris, 1964).

For all groups, accurate omission of the occluded handles was better predicted by non-verbal than verbal age whereas accurate depiction of decorative and contextual details was better predicted by chronological age than intellectual maturity. Uniquely, the developmentally normal children showed a strongly negative association between verbal capabilities and the portrayal of the pattern on the teapot. Averaged across tasks, there was no evidence of precocious drawing development by the autistic children. Instead, the minimum levels of intellectual maturity linked with drawing realism on each of the measures were at least as high for the autistic sample as for the non-autistic samples. While the autistic children achieved similar results to the non-autistic children overall, however, they differed in the pattern of their drawing accuracy across the mug/cup tasks. Although the developmentally normal and Down's syndrome groups experienced a reliable reduction in commission errors for the occluded handle from the striped mug task (no context) to the cup-and-saucer task (appropriate context) to the cup-and-flowers task (misleading context), there was no test-dependent shift in the frequency of such errors in the autistic group. Additionally, whereas the non-autistic children demonstrated levels of drawing maturity in the Draw-A-Person test that matched both their verbal and non-verbal age, results for the autistic children were congruent only with their non-verbal age. The findings are discussed in terms of cognitive deficits that have been postulated to characterize autism.

Chapter One

1. AUTISM

Autism is a pervasive developmental disorder characterized by qualitative impairments in reciprocal social interactions and patterns of communication and by a restricted, stereotyped, repetitive repertoire of interests and activities (World Health Organisation, 1992). Autism was first noted as a clinical syndrome by Kanner (1943) following his study of eleven withdrawn children who showed an indifference to the world and people around them. He described autism as an innate condition in which children suffer from an "autistic disturbance of affective contact - thus emphasising a profound disturbance of social functioning".

1.1 Symptoms of autism

The Autistic Society has highlighted four essential features of autism, first, impairment of social interaction, second, impairment of social communication, third, impairment of imagination, and fourth, repetitive, stereotyped activities.

Impairment of social interaction

The most severe form of autism manifests as aloofness and indifference to other people. Most autistic children show attachment on a simple physical level to adults they know well but are indifferent to children of their own age. In a less severe form, the child passively accepts social contact, even showing some pleasure in this, although they make no spontaneous approaches. Some autistic children approach other people spontaneously but do so in an odd, inappropriate way and pay little or no attention to the responses of the people they approach. Among the most able adolescents and adults, the social impairment sometimes evolves into an inappropriately stilted and formal manner of interaction with family and friends as well as strangers.

Impairment of social communication

Autistic children show a lack of appreciation of the pleasure of communication. This is true even of those who have a lot of speech, which they use to talk 'at' rather than 'with' others. They appear to lack understanding that language is a tool for conveying social and emotional information to others. They show difficulty in talking about feelings or thoughts and in understanding the emotions, ideas and beliefs of others. They have poor comprehension of the information conveyed by gesture, miming, facial expression, bodily posture, and vocal intonation. They lack the use of gesture, miming, facial expressions, vocal intonation and bodily posture to convey information. Those with good vocabularies have a literal understanding and use of words, an idiosyncratic, sometimes pompous choice of words and phrases, and limited content of speech.

Impairment of imagination

Autistic children show an inability to play imaginatively with objects or toys or with other children or adults. There is a tendency to select for attention minor or trivial aspects of things in the environment instead of an imaginative understanding of the meaning of the whole scene (e.g., a wheel instead of the whole toy train). Some children have a limited range of imaginative activities that they have copied, for example, from television programs. They pursue these repetitively and cannot be influenced by suggestions from other children. They lack understanding of the purpose of pursuits that involve comprehension of words and their complex associations. There is consequently a lack of motivation to indulge in these activities even if the necessary skills are available to the child.

Repetitive stereotyped activities

These can take simple or complex forms. Examples of simple stereotyped activities include flicking of fingers, objects, and pieces of string; spinning objects or watching things that spin; tapping and scratching on surfaces; inspecting, walking along and tracing lines and angles; feeling special textures; rocking, especially standing up and jumping from back foot to front foot; tapping, scratching or otherwise manipulating parts of the body; repetitive head banging or self injury; teeth grinding; repetitive grunting or screaming. Children of higher levels of ability often show complex routines. Some complex stereotyped activities involve objects, such as intense attachment to particular objects for no apparent purpose; a fascination with regular repeated patterns of objects or sounds; arranging objects in lines or patterns; the collection, for no apparent purpose, of large numbers of objects such as plastic bottles, pebbles, or the tops from tubes of sweets. Examples of complex stereotyped activities involving routines include insistence on following the identical route to certain places, insistence on a lengthy bedtime ritual, and repetition of a sequence of odd bodily movements. Examples of complex verbal or abstract repetitive activities include fascination with certain topics such as electricity, astronomy, birds, train timetables, or specific people, asking the same series of questions and demanding standard answers.

Wing and Gould (1979) argued that autism comprises a triad of impairments in the domains of socialisation, communication and imagination. First, the child's social relationships and social development are abnormal. The autistic child shows little or no interest in joining group activities or playing with other children and derives no satisfaction from being a part of a social event. They seem to regard people as inanimate objects rather than living beings with feelings, needs and emotions. Consequently, they rarely seek comfort from an adult or return a mutual glance or smile. Second, the child fails to develop normal communication. Whereas some autistic children elect to be mute, others show echolalia (repeating words and phrases they have just heard) or are obsessed with talking about a single topic such as bus timetables or numerical calculations. When a child has a sufficient range of vocabulary, language is often used repetitively and inappropriately and the context of the situation is not taken into consideration. Third, the child's interests and activities are restricted and repetitive rather than being flexible and imaginative. The autistic child is greatly lacking in imagination and is unable to indulge in any form of pretend play. Instead, they often favour activities that involve stacking or sorting, for example, spending hours at a time stacking blocks in exactly the same order, placing one object on top of another or ordering objects in a repetitive manner. They resist change and adhere rigidly to stereotyped routines.

1.2 Diagnosing autism

According to the Autistic Society, almost all children with autistic spectrum disorders show evidence of developmental abnormality in the first two or three years of life. Although some seem to develop normally in the first year or two, others show indications of developmental problems before their first birthday. There are numerous identification instruments used to diagnose autism but the two systems favoured by psychiatrists are the DSM–IV and the ICD–10:

The DSM–IV System

A. Qualitative impairment in reciprocal and social interaction.

- Marked lack of awareness of the existence of feelings of others.
- No or abnormal seeking of comfort at times of distress.
- No or impaired imitation.
- No or abnormal social play.
- Gross impairments in ability to make peer friendships.

B. Qualitative impairments in verbal and non-verbal communication, and in imaginative activities.

- No mode of communication, such as communicative babbling, facial expression, gesture, mime or spoken language.
- Markedly abnormal non-verbal communication as in the use of eye-gaze, facial expression, body posture or gestures to initiate or modulate social interaction.
- Absence of imaginative activity, such as play acting of adult roles, fantasy characters or animals, lack of interest in stories about imaginary events.
- Marked abnormalities in the production of speech, including volume, pitch, stress, rate, rhythm and intonation.
- Marked abnormalities in the form or content of speech, including stereotyped and repetitive use of speech.
- Marked impairment in the ability to initiate or sustain conversation with others, despite adequate speech.

C. Markedly restricted repertoire of activities and interests as shown by:

- Stereotyped bodily movements such as hand flicking or twisting, spinning, head banging, and complex whole body movements.
- Persistent preoccupation with parts of objects or attachment to unusual objects.
- Marked distress over changes in trivial aspects of environment.
- Unreasonable insistence on following routines in precise detail.
- Markedly restricted range of interests and a preoccupation with one narrow interest.

D. Specify if onset during infancy or childhood (after 36 months).

A. Qualitative impairments in reciprocal social interaction.

- Failure to use eye gaze, body posture, facial expression and gesture to regulate interaction adequately.
- A failure to develop peer relationships that involve a mutual sharing of interests, activities and emotions.
- Rarely seeking and using other people for comfort and affection at times of stress or distress and/or offering comfort and affection to others when they are showing distress or unhappiness.
- A lack of shared enjoyment in terms of vicarious pleasures in other people's happiness and/or a spontaneous seeking to share their own enjoyment through joint involvement with others.
- A lack of socio-emotional reciprocity, as shown by an impaired or deviant response to other people's emotions and/or lack of modulation of behaviour according to the social context and/or a weak integration of socio-emotional and communicative behaviours.

B. Qualitative impairments in communication.

- A delay in or total lack of spoken language that is not accompanied by an attempt to compensate by the use of gesture or mime as alternative modes of communication.
- A relative failure to initiate or sustain conversational interchange in which there is reciprocal to and fro responsiveness to the communication of the other person.

- Stereotyped and repetitive use of language and/or idiosyncratic use of words or phrases.
- Abnormalities in pitch, stress, rate, rhythm and intonation of speech.
- A lack of varied, spontaneous make-believe play or, when young, social imitative play.

C. Restricted, stereotyped patterns of behaviour, interests and activities.

- An encompassing preoccupation with stereotyped and restricted patterns of interest.
- Specific attachments to unusual objects.
- Apparently compulsive adherence to specific non-functional routines or rituals.
- Stereotyped and repetitive motor mannerisms that involve either hand/finger flapping or twisting or complex whole body movements.
- Pre-occupation with parts of objects or non-functional elements of play materials.
- Distress over changes in small non-functional details of the environment.

Other identification instruments used in the description of autism include the following:

- Autism Behaviour Checklist.
- Autism Diagnostic Interview.
- Autism Diagnostic Observation Schedule.
- Behaviour Observation Scale for Autism.
- Behaviour Rating Instrument for Autism and Atypical children.
- Behavioural Summarised Evaluation.
- Checklist for Autism in Toddlers.
- Childhood Autism Rating Scale.

- Diagnostic checklist for Behaviour-Disturbed Children.
- Infant Behavioural Summarised Evaluation.
- Pre-Linguistic Autism Diagnostic Observation Schedule.

1.3 The aetiology of autism

Despite extensive research, the causes of autism have yet to be determined. Most investigations into this topic have focused on possible genetic transmission, brain dysfunction (either genetically mediated or due to external causes such as birth trauma), physiological dysfunction, and a variety of environmental factors such as parenting, diet, and exposure to viruses.

Genetic factors

Genetic factors are implicated in autism given that the disorder is vastly more common in boys than in girls (a ratio of approximately 4:1 or 5:1). Additionally, twin studies have consistently found a higher incidence of autism in identical twins and siblings of autistic patients than in the general population (review by Piven & Folstein, 1994). It has also been noted that the concordance rate for autism in identical twins is higher than in non-identical twins, as would be expected if genetic factors play a role in the disorder (Folstein & Rutter, 1977; Bailey, Le Couteur, Gottesman, Bolton, Simonoff, Yuzda, & Rutter, 1995).

Brain dysfunction

Several types of brain scans are currently being used in autism research including M.R.I. (Magnetic Resonance Imaging), C.A.T. (Computed Axial Tomography), P.E.T. (Positron Emission Tomography), and S.P.E.T. (Single Photon Emission Tomography) scans. Some studies using the M.R.I. scanner have found evidence of abnormalities of the cerebellum in children and adults with autism (Piven, 1990). Courchesne, Townsend, Akshoomoff, Yeung-Courchesne, Murakami, & Lincoln (1994) suggested the cerebellum plays a role in the control of attention and thus might determine the ability to engage in joint social attention. Abnormalities in the frontal lobes have also been implicated in autism given that patients with acquired brain damage in the region of the frontal lobes often show similar psychological defects to those suffering from autism, including difficulties in planning skills together with the presence of a rigid, persevering approach to problem solving (Baron-Cohen & Ring, 1994). Alternatively, some researchers point to impaired amygdala function, consistent with abnormalities of emotion perception and expression in autism (Bauman & Kemper, 1994). Waterhouse, Fein, and Modahl (1996) argued that the risk of autistic symptoms is heightened when amygdala dysfunction co-occurs with hippocampal dysfunction.

Other physiological dysfunction

Various kinds of physiological dysfunction outside the brain have also been linked with autism. Some autistic patients appear to have abnormal levels of certain hormones or neurotransmitters, including serotonin (Buitelaar, Van Engeland, de Kogel, & de Vries, 1992, melatonin (Nir, Meir, Zilber, Knobler, Hadjez, & Lerner, 1995) secretin (Horvath & Tildon, 2001), and dopamine (Damasio & Maurer, 1978). Such research suggests possible drug treatments for autism (e.g., Cook & Leventhal, 1995).

Environmental factors

During the 1960s, many researchers believed that autism arose when parents were affectively cold and distant towards their child. It was even suggested that autistic children were victims of their socio-demographic position, having highly intellectual, upper social-class parents who were emotionally unavailable (Singer & Wynne, 1963; Bettelheim, 1967). It is much more likely that, in the early days, relatively high numbers of diagnoses made in this social bracket reflected referral bias rather than clinical fact (Aarons & Gittens, 1992). Various investigations into parental style have found no significant difference in warmth, responsiveness and sociability between parents of autistic children and parents of non-autistic children. On the contrary, many autistic children have normal siblings, indicating that the parents' behaviour is not at fault (Cantwell, Baker & Rutter, 1978).

Research into the role of environmental factors such as diet has also proved controversial. It has been suggested that autistic children have problems in metabolising casein (cows' milk protein) and gluten (wheat starch), but their disorder is not always alleviated when such foodstuffs are eliminated from their diet (Williams, 1996). Similarly, the idea that autism is caused by viruses contracted by the mother during pregnancy, or subsequently by the child, has been the subject of intense debate and speculation. Rubella, syphilis, varicella and cytomegalovirus are all viewed as possible culprits (e.g., Chess, 1977; Deykin & MacMahon, 1979; Stubbs, 1978), but the findings to date have been equivocal.

1.4 Cognitive deficits in autism

The term 'cognition' encompasses the various functions by which the brain receives, stores and processes incoming information about the environment. Cognition therefore includes attention, perception, memory, learning, judgement and thinking. In research into autism, there has been considerable interest in the question of whether autistic children have fundamental cognitive deficits that underlie their various problems with language, social interaction and imagination. Three main hypotheses have been advanced, first, that autistic children lack a theory of mind (e.g., Baron-Cohen, 1995; Baron-Cohen, Leslie & Frith, 1985), second, that they suffer executive dysfunction (e.g., Ozonoff, Pennington & Rogers, 1991; Russell, 1997), and third, that they have abnormal visuo-spatial abilities (Mitchell & Ropar, 2003).

The theory of mind hypothesis

The 'theory of mind' hypothesis of autism has been particularly influential. The term 'theory of mind' relates to the ability of normal children to attribute mental states such as beliefs, desires and intentions to themselves and others, as a way to make sense of and predict behaviour (Baron-Cohen et al., 1985; Premack & Woodruff, 1978). To have a theory of mind (ToM) is therefore to understand that other people have their own interpretations of the world and to make inferences about what other people believe to be the case in given situations. The ToM hypothesis was partly motivated by Leslie (1987), who proposed that an innate cognitive mechanism was necessary for representing mental states. Leslie's theory of mind module (ToM) generates and uses second-order representations that make sense of otherwise contradictory information. For example, a child who sees her mother pretending that a banana is a telephone has in mind facts about both objects (first-order representations). The child avoids confusion because she computes from the concept of pretending (a second-order representation) that her mother is engaging simultaneously in an imaginary and real activity (Baron-Cohen, 1995).

Evidence suggests that autistic children understand representations such as photographs but experience difficulty with tests of the understanding of mental representations. This has been demonstrated in tasks inducing children to reason about false beliefs. For example, in the Sally-Ann Test (see Baron-Cohen et al., 1985), children hear a story about a doll called Sally and another doll called Ann. Sally has a basket and Ann has a box. Sally puts her marble in her basket and then goes away. However, while she is gone, Ann takes the marble out of the basket and puts it in the box. Children are asked where Sally will look for her marble when she comes back. Baron-Cohen et al. (1985) found that the vast majority (about 80%) of children with autism (mean age 12 years) judged incorrectly that Sally would look in the box; that is, they appeared not to understand the nature of her false belief. In contrast, most normal children aged 4 years and above answered correctly that Sally would look in her basket. Baron-Cohen et al. also observed that most children with Down's syndrome were able to acknowledge Sally's false belief, despite being slightly younger on average than the children with autism and having a slightly lower verbal age.

Children with autism fail not only the Sally-Ann task but also a variety of other tasks designed to tap the understanding of false belief. For example, in the deceptive-box test (Perner, Leekham, & Wimmer, 1987; Perner, Frith, Leslie, & Leekham, 1989), children are shown a Smarties tube and are asked what they think it contains. Most children answer "smarties" or "sweets". The tube is then opened and children are shown that the tube in fact contains a pencil. The tube is closed again and children are asked what another child would probably think the Smarties tube contains. Perner et al. (1987) found that most normal 3-year-olds incorrectly answered "a pencil" whereas most normal 5-year-olds correctly answered "smarties". In contrast, Perner et al. (1989) found that most autistic children claimed that another person would predict there to be a pencil inside the tube. They further demonstrated that when children were asked to recall what they had predicted to be in the box in the first place, autistic participants (just like normal 3-year-olds; Gopnik & Astington, 1988) were usually unable to acknowledge their own false belief. That is, they reported what they knew to be inside the tube rather than what they had previously believed to be the case.

Autistic participants' failure on false-belief tasks has since been replicated in a number of procedures, for example, using real people instead of toys and using a control group of specifically language-impaired children to rule out a language deficit explanation (Leslie and Frith, 1988; Perner, Frith, Leslie and Leekham, 1989). Nevertheless, other studies have obtained results that pose difficulties for the theory of mind hypothesis. First, several investigations have shown that some children diagnosed as autistic do pass tests of false belief understanding, with the success rate ranging between 20% and 60%. Indeed, a minority of autistic children also pass tests of second-order belief attribution in which they are required to understand that people hold beliefs not just about reality but also about other people's beliefs (Bowler, 1992). Second, it has been observed that some disabled but non-autistic groups such as deaf children similarly show poor performance on theory of mind tasks (Peterson & Siegal, 1995). Third, the theory of mind account fails to explain such non-triad features of autism as a restricted repertoire of interests, a preoccupation with the parts of objects, and a lack of pretend play (Jarrold, Butler, Cottington, & Jimenez, 2000).

The executive dysfunction hypothesis

In contrast, the executive dysfunction hypothesis links autism with a disorder in higher cognitive functions such as attention, thinking and reasoning. Standard executive function measures of set shifting, inhibition and planning include the Wisconsin Card Sorting Test and the Tower of Hanoi test. Ozonoff et al. (1991) presented autistic people with the Tower of Hanoi and Wisconsin Card Sort tests and examined their performance on tests of both simple and second-order false beliefs. They found that although some autistic children failed to show a theory of mind deficit, all of them were impaired on tests of executive function. They therefore proposed that executive dysfunction rather than a lack of theory of mind underlies many of the social and non-social impairments of autism. Consistent with this view, Russell (1997) suggested impairments in executive function reflect frontal lobe dysfunction, thus explaining the repetitive, stereotyped behaviours found in autism.

Similar to the theory of mind hypothesis, however, attempts to explain autistic behaviours in terms of executive dysfunction are not without their difficulties. First, like theory of mind deficits, executive dysfunction is not unique to autism and is found in other clinical groups such as those with obsessive-compulsive disorder (Bishop, 1993). Second, people who have executive impairments caused by damage to the frontal-lobe region of the brain do not necessarily show autistic behaviours (Mitchell, 1997). The picture is further complicated by recent evidence indicating a link between theory of mind and executive function in both typical and autistic development (Frye, Zelazo, & Burack, 1998). Perner & Lang (1999) concluded that executive function and theory of mind are functionally interdependent such that an understanding of mental states is required for executive control and the exercise of executive function is one of the main bases for increasing the understanding of minds. Carlson & Moses (2001) have similarly argued that executive function, particularly inhibitory control, affects both the emergence and expression of mental state knowledge during early childhood.

Finally, a variety of claims have been made that autism is characterized by peculiarities of visuo-spatial skills. Research in this domain has examined the ability of individuals with autism to perform perceptual integration, to draw on pre-existing semantic knowledge when dealing with visual input, to switch effectively between different levels of hierachical stimuli, and to achieve deep rather than shallow processing (review by Mitchell & Ropar, 2003).

1. A weak drive for central coherence

One important observation in relation to autism has been that sufferers typically perform well on the Block Design and Object Assembly sub-tests of the Weschler Intelligence Scale (Weschler, 1981), despite otherwise showing mental retardation (e.g., Shah & Frith, 1993). Such findings have led to the suggestion that autism is characterized by weak 'central coherence.' According to Frith (1989), 'central coherence' reflects a person's ability to perceive an integrated whole from a set of parts. In the Block Design test, participants are shown complex patterns that they are asked to reconstruct using a set of patterned blocks. As the designs are noted for their strong gestalt qualities, most people have difficulty analysing them into their constituent parts. The finding that autistic children and adults demonstrate superiority over normal controls on the Block Design test can therefore be attributed to weak central coherence.

Shah and Frith (1993) further observed that non-autistic people performed better on the Block Design test when the blocks were initially spaced slightly apart than when they were pushed together. In contrast, many autistic participants performed just as well when the blocks were initially together as when they were initially apart, suggesting that they were not as distracted by the global configuration. In another experiment, Shah and Frith (1983) compared the performance of autistic participants and matched controls on the Embedded Figures Test (EFT). This test requires participants to spot a hidden figure (triangle or house shape) among a larger meaningful drawing (such as a clock). It was hypothesised that, due to their propensity to see parts rather than wholes, people with autism would spot the hidden figures more easily, and this prediction was supported.

As pointed out by Brian and Bryson (1996), however, the superior achievements of autistic individuals on the Embedded Figures Test can be explained in two ways. One possibility is that such individuals find it difficult to extract meaning from visual input, making it less likely that they will pay attention to the whole picture. Alternatively, autism might be characterized by a heightened facility to perceive parts irrespective of global meaning. According to the latter idea, central coherence deficits would better be described as deficits in perceptual integration. To disentangle these possibilities, recent research into the visuo-spatial capabilities of individuals with autism has aimed to evaluate independently their skills of perceptual integration and their ability to draw on prior semantic knowledge.

One approach to assessing perceptual integration in individuals with autism has been to gauge their responses to visual illusions. If the facility for perceptual integration is weak in autism then such individuals should not be susceptible to visual illusions (Mitchell & Ropar, 2003). In the pioneering study of this type, Happe (1996) reported that autistic children outperformed a non-autistic control group at making accurate judgements about such typical illusions as the Titchener circles. However, subsequent research by Ropar and Mitchell (1999) cast doubt on Happe's findings. Ropar and Mitchell demonstrated that autistic participants performed similarly to non-autistic participants when asked to make a manual adjustment of the size of one of the inner Titchener circles so that it matched the other. They suggested that Happe's failure to observe sensitivity to illusions in her autistic group could be attributed to her use of a verbal rather than behavioural measure, specifically, such that participants were scored for their ability to respond "same" without there being a control condition in which they would have been scored correct for answering "different". Ropar and Mitchell (1999) further demonstrated that if the appropriate control condition was included then autistic patients succumbed to visual illusions as readily as a non-autistic group even when tested verbally.

Ropar and Mitchell (2002) similarly failed to find evidence of weakened perceptual integration in autism. In their study, participants were asked to reproduce the image of a circle presented on a slant such that it appeared as an ellipse. In one condition, the circle was presented within a visual context providing abundant cues that it was really a circle. In another condition, such cues were eliminated although participants knew from prior exposure what the object was. It was found that if the strong visual cues were included then the autistic group exaggerated circularity to the same extent as the non-autistic group when reproducing the shape. They therefore appeared to have integrated the object with its visual context. Ropar and Mitchell concluded that the results of their study contradicted Happe's (1999) suggestion that people with autism have impaired perceptual integration at the level of discrete objects.

Another method of examining perceptual integration in autism has been to test sufferers for global-to-local interference in their processing of hierarchical stimuli. Abundant evidence indicates that such interference is commonplace among non-autistic people. For example, Navon (1977) showed that if participants were presented with a large letter composed of smaller letters then they were faster to identify the smaller letters when they were congruent with the large letter (e.g., small Ss within a large S) than when they were incongruent (e.g., small Ss within a large H). Mottron and Belleville (1993) found that an autistic savant E.C. experienced global interference on the hierarchical letter task to the same extent as a non-autistic comparison group, indicating he integrated the different levels of the stimulus. This basic finding has been replicated in non-savant autistic patients using similar procedures (e.g., Plaisted, Swettenham, & Rees, 1999) and, again, such evidence contradicts the idea that autism is characterized by deficient powers of perceptual integration.

As far as the ability of autistic individuals to extract meaning from visual input is concerned, research has produced conflicting findings. Mottron, Belleville, & Menard

(1999) examined the reactions of autistic versus non-autistic participants to impossible figures (e.g., the devil's fork and the Penrose triangle) and found that only the non-autistic group appreciated their oddity. The fact that the autistic group were oblivious to the impossibility of the figures could mean that they failed to connect them with relevant prior knowledge. This could indicate an impairment of semantic representations in autism or, alternatively, an impairment of access to such representations. On the other hand, Mitchell and Ropar (2003) pointed out that autistic patients might overlook the oddity of impossible figures simply because they focus their attention on lower-level detail and not because they are less likely to draw on their pre-existing knowledge when confronted with such figures.

To assess directly the effects of knowledge on autistic perception, Ropar and Mitchell (2002) considered the outcomes for their slanted circle experiment in the condition for which no visual cues were present but for which participants knew in advance that they would be seeing a circle. In this condition, unlike that where contextual cues were provided, the autistic group showed significantly less exaggeration of circularity than the non-autistic group when attempting to reproduce the figure. Thus, the autistic group showed an *attenuated* effect of prior knowledge.

In contrast, Ropar and Mitchell (2001) found no evidence that autistic children were less likely than non-autistic children to rely on prior knowledge while performing an object/colour matching procedure. Participants were confronted with a series of coloured pictures of objects that each had two colours presented alongside and were asked to select on each trial the colour that better matched the target object. Some objects had a category-associated colour (e.g., a banana, a tomato) and others did not (e.g., a balloon, a car). In the pictures shown to the children, however, the objects with category-associated colours were depicted in an incongruous colour (e.g., a blue banana). The interest on such trials was in seeing whether children chose the colour that represented the semantic match to the target (i.e., yellow) or the surface match (i.e., blue). It was found that the autistic children behaved similarly to the non-autistic children in this paradigm, tending to select the semantic match when presented with an object that had a category-associated colour and tending to select the surface match when presented with an object that had no associated colour. The results therefore suggested that there is no major impairment in autism in the ability to recruit prior knowledge when processing visual input.

2. Alternative proposals

Given the challenges to the central coherence hypothesis presented by evidence of perceptual integration and sensitivity to prior knowledge in autistic patients, researchers have sought to explain their aberrant visuo-spatial processing in other ways. Recent proposals have been informed by new findings regarding abnormal visuo-spatial skills in autism.

First, autism appears to be characterized by superior performance in visual search paradigms (e.g., searching for an tilted letter in a background of vertical letters). Such superiority is apparent both when targets are defined by a single, unique feature and when they are defined by a unique conjunction of features (e.g., searching for a red X in a background of red T and green X distracters; Plaisted, O'Riordan, & Baron-Cohen, 1998a; O'Riordan, Plaisted, Driver, & Baron-Cohen, 2001). It has also been noted that, relative to non-autistic groups, autistic adults and children are less impaired in their search speed and accuracy by increasing similarity between targets and distracters (O'Riordan & Plaisted, 2001). These findings hold up even when the autistic and non-autistic groups are matched for non-verbal ability (O'Riordan et al., 2001).

The fact that autistic individuals show superior performance in search tasks involving conjunctive targets further contradicts the central coherence hypothesis because the ability to detect targets defined by conjunctions of features requires perceptual integration (O'Riordan et al., 2001). To explain this finding, one suggestion has been that individuals with autism show enhanced discrimination, that is, reduced perception of similarity and augmented perception of difference (O'Riordan & Plaisted, 2001). This idea accords with evidence that autism is associated with heightened skills of discrimination between similar novel stimuli (Plaisted, O'Riordan, & Baron-Cohen, 1998b), and it can account for good performance in the Embedded Figures Test and the Block Design Test (O'Riordan & Plaisted, 2001). Other suggestions have been, first, that autism might reflect a deficit of endogenous attention-shifting mechanisms (Swettenham, Milne, Plaisted, Campbell, & Coleman, 2001), and second, that autistic individuals show stronger inhibitory and/or excitatory processing (O'Riordan et al., 2001).

Another important finding in autism research is that, in addition to showing global-to-local interference when confronted with hierarchical stimuli, individuals with autism suffer local-to-global interference too (Mottron & Belleville, 1993; Plaisted, Swettenham, & Rees, 1999; Rinehart, Bradshaw, Moss, Brereton, & Tonge, 2002). Importantly, local-to-global interference is not observed among people who are not autistic (Mottron & Belleville, 1993; Plaisted et al., 1999). Results for autistic groups appear to reflect a genuine difficulty in dealing with hierarchical levels given that autistic patients have no problems apprehending two different interpretations of a stimulus, as demonstrated by their unimpaired performance when tested with ambiguous figures such as the duck/rabbit (Ropar, Mitchell, & Ackroyd, 2003).

Whereas it has been suggested that local-to-global interference in autism might reflect a broader problem of executive function and, thus, inhibition (Rinehart et al., 2002), this suggestion fails to account for aspects of visuo-spatial processing that are superior in autism (Mitchell & Ropar, 2003). A different proposal is that, through a process of 'paradoxical functional facilitation', difficulties in processing input on a deep level provoke autistic patients to develop superior skills in processing on a low level (Mottron & Burack, 2001; Mottron, Morasse, & Belleville, 2001). This perspective does not assume an inherent aptitude for low-level processing in autism but, instead, implies that such an aptitude emerges with development in compensation for deficits in high-level processing. The idea of paradoxical functional facilitation allows for preserved configural processing in autism, in conflict with the central coherence hypothesis, but predicts deficits in some aspects of processing for meaning (Mitchell & Ropar, 2003).

In summary, despite the impressive body of evidence in relation to autism, the nature of the fundamental cognitive deficit remains unclear. Whereas the ToM account explains why autistic children have difficulty with joint attention, false beliefs and deception, it fails to explain preserved and superior skills in non-social areas. The executive dysfunction hypothesis similarly explains why autistic children fail on false-belief tasks but fails to account for islets of ability. Finally, research into visuo-spatial skills is consistent with the uneven pattern of intellectual disabilities observed in autism but more research is needed to explore its potential for explaining the autistic child's language and social impairments.

Recently, some investigators have suggested ways in which abnormalities in visuo-spatial skills in autism might explain the triad features of autism. For example, despite early claims that theory of mind deficits and weak central coherence are unrelated aspects of the autistic syndrome (Frith & Happe, 1994), subsequent research has indicated that central coherence is linked with theory of mind capabilities. Baron-Cohen & Hammer (1997) found that weak central coherence was predictive of poor performance on complex theory of mind tasks such as reading intentions from pictures of people's eyes. Similarly, Jarrold et al. (2000) showed that performance on theory of mind tests was inversely related to speed on the Embedded Figures Test in the general population. The Jarrold et al. study additionally found that the relation between weak central coherence and theory of mind deficits held up for typically developing children and for children with autism when verbal mental age was accounted for. Following Frith (1989), they suggested that successful performance on theory of mind tests requires a "meaningful" integration of information. For example, in everyday social interactions there is typically a need to co-ordinate attention between self, other, and the object of the other's attention (Hobson, 1993).

Proponents of the idea of enhanced perceptual discrimination have similarly argued that low-level abnormalities of visuo-spatial processing might account for high-level deficits in social cognition. For example, it has been suggested that enhanced discrimination is likely to cause diminished levels of generalization (O'Riordan & Plaisted, 2001; Plaisted, 2001). Given that the ability to generalize is fundamental to inferential thought, analogical reasoning, and categorization, it would not be surprising if enhanced discrimination produced autistic symptoms.

2. CHILDREN'S DRAWING DEVELOPMENT

2.1 Drawing development in non-autistic children

Representational drawing usually begins at about the age of 20 months and is indicated when children name their scribbles either before or after they have produced them. Nevertheless, children's productions at this stage tend to bear little or no resemblance to the real object. Human figure drawings tend to appear at about the age of 3 years and, once again, are hugely distorted relative to reality. Often, the shape of a head is set directly upon two legs and arms may or may not be present. Such forms are commonly known as *tadpole figures*. Despite the fact that children this age tend to know most features of the human body, tadpole drawers often have problems copying an adult's conventional drawing of a human figure. Realistically proportioned figures are generally not produced until the age of about 8 years, and drawings of the human figure continue to improve up to the age of about 12 years during which time children introduce a progressively greater number of fine details (Cox, 1992).

The shift from intellectual to visual realism

Young children also make errors when drawing simple objects and scenes. For example, they might represent the model from the wrong perspective or provide a mixture of viewpoints, and they often depict hidden features. A major contributor to the understanding of children's drawing development was Luquet (1913, 1927) who described the three main stages of development. First is the pre-schematic stage, or the stage of 'synthetic incapacity', taking place between two-and-a-half and five years of age. The pre-schematic stage represents children's earliest attempts to draw forms that depict some object of their experience although they generally fail in positioning, co-ordination and synthesis of elements. Second is the stage of 'intellectual realism.' Luquet argued that at this stage children's drawing reflect their underlying concepts. Hence, even when given instructions to draw a particular object from their current viewpoint, children tend to draw what they know rather than what they can see. Luquet introduced the notion of the 'internal model' which he described as representing children's understanding of the criterial properties of an object or whichever properties they believe to be most central or important. Whereas Luquet assumed that a child does not necessarily incorporate *all* their conceptual knowledge into the internal model, he argued that the internal model governs children's drawing during the stage of intellectual realism. Luquet suggested that children rely less on conceptual knowledge in producing drawings with age. Thus they eventually attain the third and final stage of drawing development, that of 'visual realism'. This stage, characterized by relatively true-to-life representations of visual scenes from one fixed viewpoint, is usually reached after the age of ten years.

Although recent research has suggested that the developmental progression from intellectual to visual realism occurs at an earlier age than Luquet thought (namely, at around 7 years), his basic findings have been replicated in many studies. For example, Freeman and Janikoun (1972) presented children with a mug that had a picture of a flower painted on the outside surface. Children were allowed to inspect the mug and to identify it as a mug before the drawing task commenced. The mug was then positioned on a table so that children could not see the handle although they could see the picture of the flower. The children were instructed to draw the mug exactly as it looked to them from where they were sitting. Freeman and Janikoun found that the children aged 7 years and above usually produced accurate drawings, that is, they omitted the handle and included the flower. By contrast, the younger children tended to include the handle and omit the flower, thus showing intellectual realism. Freeman and Janikoun agreed with Luquet in suggesting that young children draw from their internal model of an object rather than from reality. Hence, they portray typical or generic features (i.e., the handle) but not idiosyncratic features (i.e., the flower).

Nevertheless, Luquet's model of drawing development has been criticised due to findings that children as young as four years produce view-specific drawings in some circumstances. For example, Cox (1981) showed that 6-year-olds who were unable to partially occlude a ball placed behind a toy wall were nevertheless able to produce a realistic drawing of a toy policeman 'hiding' behind the wall. Similarly, Littleton & Cox (1989) induced 7-year-old children to depict partial occlusion when balls were given faces and when one character 'hid' behind another. Both Cox (1991) and Light and Foot (1985) demonstrated that any scene in which the two objects are dissimilar encourages visually realistic drawings. For example, a ball behind a wall usually elicits partial occlusions, but not a ball behind a ball, or a wall behind a wall.

When young children are asked to draw a mug or cup with its handle hidden from view, the incidence of commission errors can be reduced if the importance of orientation is emphasised either by contextual manipulations or explicit instructions. Using the former approach, Davis (1983, 1985) evaluated drawing accuracy among 4- to 5-year-olds who were shown either one or two cups. When presented with a single cup, most children incorrectly included the handle in their drawings. When they were presented with two cups, one with an occluded handle and one with a visible handle, they tended to portray the handle only on the cup for which it could actually be seen. Davis concluded that children relied on the presence of the cup with a visible handle in their drawing to indicate the identity of the second object. Using the second approach, Lewis, Russell & Berridge (1993) showed that 5-year-olds were more likely to avoid a commission error when they received strongly worded instructions that the exact appearance of the model was required than when they were mildly requested to draw realistically.

Barrett & Light (1976) suggested that Luquet's theory regarding the progression from intellectual to visual realism by young children should be modified to include three distinct stages of drawing ability. The first stage, termed 'symbolism', occurs when children draw what they believe to be the important features of the particular concept represented by the model. The second stage, 'intellectual realism', occurs when children draw what they believe to be the important features of the individual model itself. The third stage, 'visual realism', occurs when children draw the model exactly as it appears from their current viewpoint. It is obvious from this description that 'symbolism' in Barrett & Light's model corresponds to 'intellectual realism' in Luquet's model and that 'intellectual realism' in Barrett & Light's model represents a more advanced stage of drawing development not recognised by Luquet. Taylor & Bacharach (1982) found support for Barrett & Light's model in two experiments. Their first study examined whether 5-year-old children could be induced to include non-defining information in their depiction of a cup with an occluded handle. It was found that about 60% of the sample *did* depict a picture of a flower on the cup (i.e., a non-defining feature) if it was located on the inside rather than the outside surface of the cup. Taylor and Bacharach therefore suggested that the participants in Freeman & Janikoun's (1972) study omitted a flower positioned on the outside surface of a cup because to include it would have violated their drawing conventions. Specifically, they postulated that young children draw one object within the outline of another object only if they wish to convey the idea of containment. In their second study, Taylor & Bacharach asked 5-year-old children to draw a cup with a handle that had been broken off. As for traditional tests of intellectual realism, the cup was positioned so that its broken handle could not be seen. Despite making commission errors in a drawing condition for which the occluded handle was intact, almost all the children drew realistically when the handle was broken. These results therefore support Barrett and Light's idea that young children pass through a stage in which they are motivated to depict all the important features of the drawing model, both defining and non-defining, before they achieve true drawing realism.

Children's drawings and intellectual maturity

In other work, researchers have examined the extent to which children's drawings are diagnostic of their wider intellectual maturity. In pioneering research, Goodenough (1926) devised the 'Draw-A-Man' test of intellectual functioning. This test uses a child's elaboration of the human figure in terms of such items as number of details and body parts, proportion and position as an indicator of their intelligence. Harris (1964) revised and updated this work to produce the 'Draw-A-Person' test, producing separate tables of gender-specific norms to accommodate persistent findings of superior performance in girls relative to boys. Consistent with the idea that drawing skills are related to cognitive development, some studies have found significant, positive correlations between children's achievements on the Draw-A-Person test and their I.Q. scores (e.g., Abel, Von Briesen, & Watz, 1996). Nevertheless, the Draw-A-Person test is widely regarded as an index of actual rather than potential cognitive functioning (Cox, 1993).

2.1 Drawing development in autistic children

Given the profound social and cognitive deficits that characterize autism, an obvious question to have been raised in the literature is whether autistic children differ from non-autistic children in their drawing development. In an early investigation of this issue, Lark-Horowitz, Lewis and Luca (1967) found that autistic patients showed a preference for drawing unconventional subjects, for example, yachts, churches, windows, and horses. Selfe (1977, 1983) similarly observed the drawings of her autistic group to be dominated by unusual objects whereas a matched group of non-autistic children preferred to adhere to familiar subjects such as flowers, houses, and people. Selfe also noted that whereas normal children invariably discussed and named their drawings and sought parents' comments and approval about their work, none of the autistic children in her sample would either name or describe their drawings. They instead seemed to draw only for personal pleasure and satisfaction. In Selfe's research, parents of autistic children reported that their child began to draw at a later age than did normal children and that their first attempt at drawing tended to produce a recognisable object without the preliminary scribbling stage. More recently, Lewis & Boucher (1991) examined possible differences in drawing style between autistic children and learning-impaired, non-autistic children who were matched in terms of chronological and mental age. They found no obvious discrepancies between the drawings of the groups in terms of content. However, in comparison to the normal children, the autistic group showed a restricted range of ideas for generating drawings. Similarly, Craig, Baron-Cohen and Scott (2001) found that autistic children were impaired relative to controls in their ability to draw imaginatively.

Other research has examined whether autistic children show precocious development of drawing skills relative to non-autistic children. Interest in this topic has been inspired by the observation that a small minority of autistic children show drawing ability that is considerably advanced relative to their mental age (e.g., Sacks, 1985; Selfe, 1977, 1983). For example, Self (1977) reported the case of Nadia who, with a chronological age of 6 years and a mental age of only 3 years and 3 months, drew pictures of horses that were visually realistic in such aspects as occlusion, size-scaling, and perspective. There has also been widespread public interest in Steven Wiltshire, an autistic boy who has published three books of his accurate and highly detailed drawings of buildings (Wiltshire, 1987, 1989, 1991). Selfe (1977, 1983) suggested that such artistically gifted children with autism proceed through the same developmental stages of drawing as normal children but at a faster rate. They therefore produce visually realistic drawings at a much earlier mental age.

Interestingly, it has been observed that autistic savants sometimes lose the ability to draw in a visually realistic way once language develops (Selfe, 1983). Such evidence has led to the suggestion that it is an inability to conceptualise in autism and hence, a lack of assumptions and expectations about what is to be seen in the environment, that is responsible for instances of outstanding artistic ability (Snyder & Thomas, 1997). According to this view, as autistic individuals begin to develop the symbolic schemata of language they develop expectations about the properties of objects that interfere with their ability to produce a naturalistic depiction of them.

Alternatively, the talents of gifted autistic artists have been attributed to their propensity to weak central coherence. Hermelin, Pring & Heavey (1994) demonstrated that autistic savants who were gifted at visual art performed better than controls in manipulating segmented visual displays. They concluded that skills in segmentation and analysis might be of great benefit in drawing and painting. Pring, Hermelin & Heavey (1995) examined whether weak central coherence was characteristic of the cognition of gifted autistic artists and mental age matched controls with similar superior artistic ability. The performance of both gifted groups was compared with the performance of control autistic and non-autistic groups who showed no special aptitude for drawing. Participants were asked to reconstruct from blocks both complex, meaningful scenes and abstract, non-representational patterns. At least for the latter task, the presence or absence of artistic talent influenced the speed at which the puzzles were completed such that the artistically gifted groups performed faster than the non-gifted groups. Whereas there was no difference in completion speed between the artistically gifted normal children and the autistic savants, the autistic control group were faster at solving the block designs than the non-autistic control group. Block design performance in the autistic groups was uncorrelated with either chronological or mental age, supporting the idea of islets of ability in autism (Shah & Frith, 1993). Pring et al. concluded that a facility for visually decomposing wholes into their constituent parts is likely to be an important component of artistic ability in regards to drawing and painting. Hence, they argued that weak central coherence could account for the existence of gifted artistic ability in a minority of autistic children.

Additionally, some researchers have appealed to the idea of weak central coherence to explain differences in drawing skills between normal children and autistic children who are not artistically gifted. First, Fein, Lucci & Waterhouse (1990) found that non-savant autistic children were more likely than normal children to show geometric design overlap, human figure overlap, and human figure fragmentation in their drawings. Second, in a study that examined copying skills in autistic versus non-autistic groups, Mottron, Belleville, & Menard (1999) found that autistic participants produced more local features at the start of the copying process and were less affected by figure impossibility. Both sets of results are consistent with the notion that autistic children experience a local bias in perceiving scenes and objects.

Charman & Baron-Cohen (1993) argued that if superior artistic ability in a minority of autistic individuals is a consequence of cognitive characteristics that are prominent in the wider autistic population then even autistic children without gifted drawing ability should show precocious drawing development. To investigate this claim, they examined the link between mental age and the transition from intellectual to visual realism in autistic children who showed no exceptional drawing ability as well as in normally developing children and mentally handicapped but non-autistic children. Participants were assessed for verbal ability using the British Picture Vocabulary Scale (BPVS) and non-verbal ability using Raven's Coloured Progressive Matrices (RCPM). They were later asked to make a series of drawings, namely, a mug with its handle occluded, a cube, and a ball versus a doll partly occluded behind a wall. In contrast to predictions, results were similar for the three groups. The participants with autism who predominantly showed visual realism (i.e., producing no more than a single intellectually real drawing) were not reliably older than participants with autism who did not but all had a non-verbal mental age of 66 months or above. This developmental shift mirrored the results for the normal group, in which all participants who predominately showed visual realism had a non-verbal mental age of 74 months or above, and the Down's syndrome group, in which no child was classified as showing predominant visual realism and in which no child attained a non-verbal mental age in excess of 66 months. Charman & Baron-Cohen concluded that for autistic children who are not artistically gifted, as for non-autistic children, the progression from intellectual to visual realism is predicted by mental age, especially non-verbal mental age.

Charman and Baron-Cohen argued that demonstrations of intellectual realism in autistic children are consistent with the meta-representation theory of autism. According to Leslie (1987), autistic individuals are selectively impaired in their ability to construct mental representations of mental representations. Because intellectual realism is drawing what is known rather than only what can be seen, its existence in autistic children indicates that they are capable of mentally representing other kinds of information. Indeed, when Charman and Baron-Cohen compared the results for the ball-and-wall task with those for the doll-and-wall task they found support for the idea that autistic children have difficulty representing mental states. Following Cox (1981), this comparison evaluated participants' ability to depict one object occluding another either with or without a social context by asking children in one task to depict a ball partially occluded by a wall and in a second task to portray a doll 'hiding' behind the wall (see also, Cox, 1985; Light & McEwan, 1987; Littleton & Cox, 1989). Charman & Baron-Cohen predicted that because of their impairments in developing a theory of mind, reference to an implicitly mental activity such as hiding would not affect drawing skill in children with autism. This prediction was supported. For the normal group and those with mental handicap, introducing a social context to the visual display increased the proportion of children who produced visually real drawings. However, the same manipulation failed to increase the number of visually realistic drawings produced by the children with autism.

Eames and Cox (1994) attempted a similar investigation to Charman & Baron-Cohen (1993) although they matched their autistic and non-autistic groups more closely in terms of non-verbal mental age. They also examined the drawing performance of a group of non-autistic children with Down's syndrome. Drawing ability in all groups was measured in terms of commission errors for defining features, attention to detail, depiction of spatial relationships between objects, and use of depth cues such as total and partial occlusion and converging perspective lines. The study found no evidence that drawing skills in the autistic group were more advanced than those in the non-autistic groups. Indeed, for many tests results were inferior in the clinical groups relative to the developmentally normal children. For example, when shown two balls with one partially occluded behind the other, both clinical groups were more likely than the normal children to portray the balls separately. Eames & Cox therefore concluded that exceptional artistic ability in some autistic individuals is likely to be a consequence of special aptitudes that are *not* common to the majority of autism sufferers.

Although not concerned with children's ability to draw objects directly from perception, the study by Lewis and Boucher (1991) also shed some light on drawing skills in autism. In this investigation, children were asked to draw objects and scenes of their own choosing from imagination and their productions were assessed for realism in terms of proportionality, diminishing size with distance, occlusion, and representation of three dimensions. Consistent with the results obtained by Charman and Baron-Cohen (1993) and Eames and Cox (1994), the drawings of the autistic sample were shown to be equivalent to those of the non-autistic developmentally delayed sample in their realism, complexity and level of detail. Lewis and Boucher additionally asked participants to draw a person from imagination and evaluated their performance using the scoring criteria for the Goodenough-Harris Draw-A-Person test (Harris, 1964). There was no difference in the outcomes for autistic and learning-impaired non-autistic children, with scores being consistent with mental age in both groups. Similarly, Watanabe, Naganuma, Setoya, Osada, Tachimori, Kubota, and Kurita (2002) observed that children with pervasive developmental disorder accompanied by autistic tendencies performed at lower than age-expected levels on the Draw-A-Man test, although their scores were significantly higher than on a standard test of cognitive ability (the Tanaka-Binet test).

In summary, investigations of drawing development have uncovered few differences between autistic children, at least those who are not artistically gifted, and non-autistic children. Despite some evidence that autistic children are less imaginative and conventional in their choice of drawing topics than non-autistic children (Craig et al., 2001; Lark-Horowitz et al., 1967; Lewis & Boucher, 1991; Selfe, 1977, 1983), they show equivalent drawing skills. Thus, just as for normally developing children, autistic children make commission errors for occluded features and they fail to make the transition from intellectual to visual realism before a mental age of approximately 6 years (Charman & Baron-Cohen, 1993; Eames & Cox, 1994). Nevertheless, drawing ability in autism appears to deviate from normal when the drawing tasks expose central coherence and theory-of-mind deficits. Autistic children are more likely to show a local as opposed to global bias when copying pictures of objects and scenes (Fein et al., 1990; Mottron et al., 1999) and their success at portraying occlusion is unaffected by manipulations of the social context (Charman & Baron-Cohen, 1993).

3. THE PRESENT STUDY

To date, the studies by Charman and Baron-Cohen (1993) and Eames and Cox (1994) represent the only published research to have compared drawing skills in autistic and non-autistic children using real objects as drawing models. The present investigation followed the lead of these studies by asking autistic and non-autistic children to draw a series of visible objects, all positioned such that a single, important feature was hidden from their view. Importantly, however, it extended previous research in several ways. First, participants were shown drawing models with both generic and non-generic attributes, permitting a more stringent test of the transition from intellectual to visual realism. Second, cognitive indices of drawing realism were evaluated using a wider range of intellectual measures than in the past. Third, new drawing tasks were developed to examine the effects of functional context on children's susceptibility to commission errors for a mug or cup with an occluded handle. Fourth, all participants were given a pre-test that assessed their understanding of view-specificity in pictures. Finally, results for the object-drawing tests were compared with those of the Draw-A-Person test (Harris, 1964). Here, participants were evaluated for their drawing maturity when asked to produce a self-portrait from memory.

Following Eames and Cox (1994), the results for a group of autistic children were compared with those for two groups of non-autistic children, namely, developmentally normal children and Down's syndrome children. The Down's syndrome group was included to see whether any possible differences between the drawings of autistic and normal children are a specific effect of autism or a more general effect of mental retardation.

1. Assessing the shift from intellectual to visual realism

The studies by Charman and Cohen (1993) and Eames and Cox (1994) compared the ability of autistic and non-autistic children to achieve a realistic depiction of a mug with an occluded handle. As pointed out by Freeman and Janikoun (1972), however, a stronger test of children's ability to attain visual realism involves checking not only whether they avoid commission errors for occluded generic features but also whether they choose to portray visible attributes of the drawing model that are idiosyncratic rather than generic. They reasoned that children who have reached the stage of visual realism should attempt to depict all the view-specific features of the model even if they are merely decorative. For example, Taylor and Bacharach (1982) found that 5-year-olds readily depicted a flower decal placed on the inside surface of a mug. Given that no such tests have yet been carried out with autistic children, it might be premature to conclude that they show similar drawing development to non-autistic children. Despite the fact that autistic children fail to differ from non-autistic controls in the typical age at which they learn to avoid commission errors for hidden generic attributes, they might nevertheless show precocious portrayal of visible non-generic details.

To examine this possibility, the present investigation used drawing models that assessed children's ability *both* to omit an occluded generic feature *and* to include a visible, decorative (i.e., non-generic) feature. The first model was a striped mug with its handle occluded. The second model was a plain coloured teapot, again with its handle occluded, and decorative information took the form of a single bold pattern (namely, a green triangle) placed just above the spout. For the mug task, stripes were chosen as the decorative feature to avoid challenging any drawing conventions children might have regarding the portrayal of containment. Taylor & Bacharach (1982) reported that 5-year-old children were reluctant to depict a picture of a flower on the outside of a mug because they feared this might be interpreted as a flower *inside* the mug. They therefore portrayed the flower only when it was located on the mug's inner surface. In the present case, it seems unlikely that a drawing of a mug with stripes could falsely be perceived as a drawing of a mug with something inside it. Hence, there would seem to be no impediment to children displaying visual realism if they have attained this stage of drawing development. Whereas children's conventions for depicting containment might potentially damage their chances of achieving visual realism in the teapot task, it was attempted to circumvent such difficulties by emphasizing the importance of the pattern as an identifying feature. Accordingly, immediately before the drawing task the experimenter showed children *two* teapots which were identical except for the fact that one teapot had a green triangle above its spout and the other had a green circle above its spout. The experimenter explained to the children that one teapot belonged to her (namely, the one with the triangle) and that the other belonged to her friend (namely, the one with the circle) and that the pattern above the spout was the only way of telling the teapots apart.

Following Charman and Baron-Cohen (1993), participants in all groups were tested for *both* verbal and non-verbal mental age. Verbal mental age was assessed using the British Picture Vocabulary Scale (i.e., BPVS; Dunn, Dunn, Whetton & Pintillie, 1982) and non-verbal mental age was assessed using Raven's Coloured Progressive Matrices (i.e., RCPM; Raven, 1956). In addition, two other measures of intellectual maturity were obtained.

First, participants in both clinical groups were tested for central coherence using the Block Design subtest of the Wechsler Intelligence Scale for Children (WISC). Given evidence that weak central coherence is associated with superior drawing ability in autistic adults (Pring et al., 1995), it is of interest to see whether Block Design scores are predictive of the shift from intellectual to visual realism in autistic children.

Second, participants in all groups were assessed for theory-of-mind development using the Sally-Ann test. Gopnik, Slaughter, and Meltzoff (1994) suggested that an understanding of visual perception might be an important precursor of the understanding of belief. They speculated that, like beliefs, perceptions are representational states that can sometimes be inaccurate or false. Evidence suggests that young children only gradually acquire the understanding that an object can be visible to them but invisible to others and vice versa, with this ability not in place before the age of about 2 ½ years. At about the age of 3 years, they acquire the understanding of perceptual misrepresentation in tasks where they are asked about the appearance of an object behind a coloured screen (Flavell, Everett, Croft, & Flavell, 1981). Importantly, Gopnik et al. (1994) reviewed evidence that success on such higher-level perspective-taking tasks appears at a slightly younger age than success on false belief tasks, raising the possibility that children might use perceptual misrepresentation as a model for false belief. They found that giving children experience with perceptual misrepresentation appeared to accelerate conceptual change as gauged by the fact that those children who received such training subsequently performed better on false belief tasks than a matched control group. The notion that children generalize their understanding of misrepresentation from perceptual contexts to concepts about false belief suggests that, in the present study, success on the Sally-Ann test might be largely confined to those participants who reliably avoid commission errors for the occluded handles.

3. The effects of functional context on children's drawing accuracy

Baron-Cohen & Charman (1993) found that autistic children's ability to depict one object partially occluding another was unaffected by manipulations of the *social* context. That is, in contrast to the results for a non-autistic group, introducing the notion of 'hiding' to explain why one object was placed behind the other failed to produce an increase in the incidence of visually realistic drawings by the autistic sample. To date, however, there has been little investigation of how autistic children's drawing accuracy might be affected by manipulations of the *physical* context. In research with non-autistic children, Davis (1983) observed that participants were less likely to depict the hidden handle of a mug if it was paired with another mug for which the handle could be seen. Because commission errors were more frequent when the cup was paired instead with a sugar bowl, Davis concluded that, in the first instance, children assumed the presence of the fully visible mug in their drawing made it clear what the second object was. Eames and Cox (1994) repeated the single- versus paired-cup task with autistic children and discovered that their performance failed to vary across the two conditions. Thus, children were no more likely to show visual realism in the paired cup task than in the single cup task. This null result is difficult to interpret, however, given that the manipulation of context in the Eames and Cox study was similarly ineffective for a group of Down's syndrome children and developmentally normal children.

Accordingly, the present investigation examined whether autistic children differ from non-autistic children in their attention to contextual relations during drawing. Specifically, it aimed to see whether children's ability to achieve a realistic depiction of a mug or cup with an occluded handle was affected by the presence of contextual features that conveyed information about the identity of the model. Children's performance in the striped mug test was compared with their performance in two additional drawing tasks, one presenting an appropriate functional context (the cup-and-saucer task) and the other presenting a misleading functional context (the cup-and flowers task). In the first task, children were shown a teacup and saucer; in the second task, there was no saucer and, instead, flowers were placed in the cup. In both cases, children were asked to produce a realistic drawing from their viewing perspective. The work of Davis (1983) suggests that, relative to the striped mug task, children will be more likely to depict the hidden handle in the teacup-and flowers task and less likely to depict the hidden handle in the teacup-and-saucer task. This is because the presence of the flowers wrongly gives the impression that the object is a vase whereas the presence of the saucer signifies that it is a cup. If this prediction is upheld for the autistic as well as the non-autistic group then it will provide an important demonstration that autistic children are sensitive to at least some kinds of contextual relations during drawing.

As well as shedding light on possible context effects, the inclusion of the cup-and-saucer and cup-and-flowers tasks provided a further opportunity to assess children's drawing skills by rating their accuracy at depicting both the saucer and the flowers. Importantly, unlike the case for the decorative details used in the mug and teapot tasks, accurate portrayal of the saucer and the flowers required that children refrain from depicting information that could not be seen, namely, the occluded section of the saucer and the occluded stalks of the flowers. These tasks therefore made it possible to see whether children who made commission errors for the hidden handle of the cup were similarly prone to make commission errors for other kinds of occluded details.

4. Assessing children's understanding of view-specificity in pictures

Another innovation of the present research was that participants in all three groups were given a pre-test to assess their understanding of view-specificity in pictures. This involved asking them to choose which of two photographs of an object (a front view versus a rear view) correctly represented that object as they could see it from their current viewing perspective. Previous studies of the shift from intellectual to visual realism did not check that children understood the instructions to produce a view-specific depiction. This is an important consideration when dealing with clinical groups that have delayed language development such as autistic and Down's syndrome children. In the present case, only the participants who passed the pre-test went on to receive the tests of drawing ability and cognitive maturity. If superior drawing performance is shown to be associated with higher verbal mental age in the present study then this cannot be attributed to any failure to understand the drawing instructions on the part of those children with low verbal skills.

5. The Draw-A-Person Test

The final drawing test administered in the present research was the Goodenough-Harris Draw-A-Person test (Harris, 1964). Both Lewis and Boucher (1991) and Watanabe et al. (2002) found no difference in the results for autistic and learning-impaired non-autistic children on this measure. However, they did not compare the performance of autistic children with developmentally normal children. In the present case, participants in all groups were requested to draw a self-portrait from memory. Rather than judging the extent to which their picture showed a photographic resemblance to their self, interest centred in determining its maturity in terms of feature completeness and proportionality (Harris, 1964). Results were inspected to determine whether children's scores on the Draw-A-Person test were positively correlated with their scores on the various measures of intellectual maturity and with their scores for the object-drawing tasks.

Chapter Two

METHOD

Participants

Participants were selected from three groups, first, developmentally normal children (i.e., the control group), second, autistic children, and third, Down's syndrome children. There were 27 children in the control group, 16 boys and 11 girls, ranging in age from 3 years 7 months to 7 years 5 months (*M*: 5:2, *SD*: 10). The children were recruited from three mainstream primary schools in the South Wales area with the majority being from middle-range SES backgrounds. There were 23 participants in the autistic group, 21 boys and 2 girls, ranging in age from 7 years 4 months to 16 years 6 months (*M*: 11:10, *SD*: 33) One child was attending a mainstream school where she received support from a care assistant. The remaining children were recruited from a variety of autistic units and special schools located in the County of Carmarthenshire, the City and County of Swansea, and the County and Borough of Bridgend. Whereas four of these children had a mild form of autism, the remainder suffered at a more severe level and produced little or no language. There were 15 participants in the Down's syndrome group, 9 boys and 6 girls, ranging in age from 8 years 6 months to 16 years 9 months (*M*: 12:2, *SD*: 38). One member of this group similarly attended a mainstream school and received one-to-one support throughout the school day with a care assistant. The remaining children attended special schools and units for children with learning difficulties. These schools were located in the County of Carmarthenshire and the City and County of Swansea.

Participants were recruited for this study following a discussion between the researcher and the head teacher of each establishment. In these interviews, the researcher provided a detailed description of each test to be undertaken and, in the case of the clinical groups, the head teacher helped to identify children who would have the best chance of completing the various procedures. Consent was additionally sought from the parent/guardian of each child in a letter before proceeding with the investigation (see Appendix A for a copy of the information sheet and the permission note).

Materials

The materials used in the investigation comprised a teddy bear, doll, striped mug, two teapots, a cup and saucer, artificial flowers, and two small plastic figurines.

Procedure

Permission to carry out the investigation was granted by the Bro Taf Ethics Committee and the Department of Psychology Ethics Committee at the University of Wales Swansea. Before any drawing tests or tests of intellectual maturity were administered, a pre-test was carried out to see whether participants comprehended instructions about view-specificity in pictorial representation. They were first given a teddy to examine, then the teddy was placed on a table in front of them and oriented such that it was facing in the other direction. Children were informed that they were going to see two pictures of the teddy and that they should point to the picture showing the teddy as it looked from where they were sitting. Two pictures were presented simultaneously, one showing the teddy from the front and the other showing the teddy from the back, and children were asked to select the appropriate picture. Next, the teddy was removed and replaced by a doll and the task was repeated. If a child failed to select the correct picture on both occasions then they were not tested further. All the children in the control group passed the pre-test. However, failures were recorded for two autistic children and one Down's syndrome child and these children were therefore excluded from the final sample. Examples of the photographs used in the pre-test are presented in Appendix B.

For children who passed the pre-test, administration of the drawing tasks and cognitive tests took place over at least two sessions, with each session lasting no longer than about 40 minutes. Except for the fact that all the drawing tests were presented *before* the tests of cognitive ability, the order of presentation of the tasks was randomised across participants. The pace of the test administration was adapted to suit each child and testing was discontinued if they appeared to be fatigued or distracted. If children were unwilling or unable to do a particular task then they were not pressured to continue. It was explained to participants before the drawing tasks that the researcher wished to keep their pictures. After each task was completed, their drawing performance was praised.

Drawing tasks

1. The mug task The child was shown a striped mug and told, "This is what I drink my coffee from at playtime". The researcher gave a simulated demonstration of sipping from the mug and then handed it to the child to examine. The mug was next placed on the table in front of the child and positioned so that its handle was hidden from view. The child was then provided with a blank sheet of paper and a pencil and asked to "draw the mug exactly as it looks to you from where you are sitting".

2. The teapot task The child was shown two white teapots identical except for the fact that one had a green triangle above the spout and the other had a green circle above the spout. These patterns were pointed out to the child and it was explained that the teapot with the triangle belonged to the researcher and the teapot with the circle belonged to her friend. The child was then asked to recall which teapot belonged to which person. Next, the teapot with the circle was put away and the remaining one was placed on the table in front of the child and oriented such that its handle was hidden from view but the spout and shape were both visible. The child was asked by the researcher to "draw *my* teapot exactly as it looks to you from where you are sitting".

3. The cup-and-saucer task The child was shown a plain coloured cup and saucer and given the opportunity to examine them. The cup was placed on the saucer and turned so that its handle was hidden from view. The child was asked to "draw the cup exactly as it looks to you from where you are sitting".

4. The cup-and-flowers task The child was shown a cup and a small bunch of artificial flowers. The flowers were placed in the cup, which was then placed on the table and turned so that its handle was hidden from view. Again, the child was asked to "draw the cup exactly as it looks to you from where you are sitting".

5. The Draw-A-Person test For the Draw-A-Person test, the child was asked to draw a picture of their self. This meant that female participants drew a female person and male participants drew a male person, as recommended by the test authors. The results were assessed according to the scoring criteria of Harris (1964).

Tests of intellectual maturity

Children's verbal intelligence was measured using the British Picture Vocabulary Scale (Dunn et al., 1982) and their non-verbal intelligence was measured using Raven's Coloured Progressive Matrices (Raven, 1956). Children were also tested for their understanding of false belief using the Sally-Ann test (e.g., Baron-Cohen et al., 1985). Finally, participants in both clinical groups were tested for their central coherence using the Block Design subtest of the WISC (Wechsler, 1991). The BPVS, RCPM and Block Design tests were administered according to the standard instructions, except in cases where some gesturing was required to encourage children to respond. The Sally Ann test involved the use of two plastic figurines, one of a fair-haired girl and the other of a dark-haired girl. The figurines were introduced as friends named Sally and Ann. After allowing the child to touch and examine the figurines, they were told the following story, "Sally has a marble and one day she places her marble into her basket. When the bell rings, Sally goes outside to play. Now while Sally is outside playing, Ann comes into the classroom. Do you know what she does? Ann takes the marble out of the basket and hides it in her box. Isn't that naughty! Sally then comes in to the classroom and looks for her marble. Where do you think she will look for it, in the basket or in the box?"

Chapter Three

RESULTS

The results are presented in seven sections. Sections 1 to 5 deal with the findings for the entire sample. Section 1 describes group means of achievements on the tests of intellectual maturity, namely, tests of verbal and non-verbal intelligence, the understanding of false belief, and central coherence. Section 2 examines the incidence of intellectual versus visual realism in each object-drawing task, focusing on children's ability to avoid a commission error for the occluded handle and their accuracy at depicting decorative and contextual details. Section 3 examines cognitive indices of visual realism in each group; first, by determining the minimum levels of intellectual maturity associated with accurate performance on each drawing measure; and second, by examining the correlations between the various measures of intellectual maturity and drawing realism. Section 4 investigates whether children's ability to avoid commission errors for the occluded handle of a mug or cup is affected by the presence of contextual features that provide clues about the model's identity. Finally, Section 5 analyses the results of the Draw-A-Person test. Examples of children's drawings are in Appendix C.

Sections 6 and 7 focus on the performance of selected sub-groups of children. Section 6 re-examines the incidence of visual realism on each of the drawing measures using a subset of children from the control and autistic groups closely matched on a 1:1 basis, first, in terms of verbal age (BPVS scores), and second, in terms of non-verbal age (RCPM scores). Section 7 looks for evidence of gender differences in drawing ability among participants in the control group.

1. Group differences in intellectual maturity

The first set of analyses evaluated group differences in mean levels of intellectual maturity. Table 1 presents the results for chronological age in months *(Age)*, BPVS age-equivalent scores *(BPVS)*, RCPM age-equivalent scores *(RCPM)* and, for the autistic group, Block Design age-equivalent scores *(BD)*. It was impossible to derive Block Design age-equivalent scores for the Down's syndrome group because they uniformly achieved a lower level of performance than accommodated by the conversion tables (i.e., lower than an age-equivalent of 72 months).

Table 1. Group means (and standard deviations) of chronological age and intellectual maturity

	Age	*BPVS*	*RCPM*	*BD*
Control	62.6 (9.9)	57.1 (14.4)	69.2 (23.0)	-
Autistic	142.0 (33.2)	68.1 (40.0)	95.3 (32.5)	91.8 (20.9)
Down's	147.9 (37.6)	51.3 (17.6)	49.4 (20.0)	-

As can be seen, the control group attained outcomes on the tests of intellectual maturity that were in line with their chronological age. In contrast, both clinical groups showed substantial deficits for both verbal and spatial ability. Whereas the Down's syndrome children demonstrated similar levels of age-equivalent performance across measures, the autistic children were more severely impaired in their BPVS scores than in their RCPM and Block Design scores.

One-way ANOVAs were used to compare the results for the three groups on the BPVS and RCPM measures. The groups failed to differ significantly in their performance on the BPVS, $F(2, 61) = 1.96, p > .05$. However, a significant outcome was obtained for the RCPM data, $F(2, 61) = 14.46, p < .001$. Tukey (hsd) comparisons found that the differences between all pairs of means were reliable (all p values $< .05$).

Inspection of the results for the Sally Ann theory-of-mind test (ToM) indicated that the control group outperformed the clinical groups (Control group: 10 fail and 17 pass; Autistic group: 14 fail and 9 pass; Down's syndrome group: 10 fail and 5 pass). However, a Chi-square analysis found no reliable association between group membership and performance on the ToM measure (Pearson Chi-square = 4.44, df = 2, $p = .11$).

Next, analyses were carried out to determine the extent to which results for chronological age and the measures of intellectual ability were positively associated. Accordingly, Pearson product-moment correlation coefficients were calculated between chronological age, BPVS scores, RCPM scores and, for the clinical groups, Block Design scores. It was found that age was positively associated with BPVS scores in all three groups. However, only the clinical groups showed a significant positive correlation between their BPVS and RCPM scores. Tables 2 to 4 present the results for the control group, the autistic group, and the Down's syndrome group respectively.

Table 2. Relations between measures of intellectual maturity in the control group

	Age	*BPVS*	*RCPM*
BPVS	.592***		
RCPM	.293	.221	
ToM	-.093	-.013	.161
BD	–	–	–

*$p < .10$ **$p < .05$ ***$p < .01$ (2-tail)

Table 3. Relations between measures of intellectual maturity in the autistic group

	age	*BPVS*	*RCPM*
BPVS	.618***		
RCPM	.290	.677***	
ToM	.395*	.335	.166
BD	-.101	.452**	.658***

*$p < .10$ **$p < .05$ ***$p < .01$ (2-tail)

Table 4. Relations between measures of intellectual maturity in the Down's syndrome group

	age	*BPVS*	*RCPM*
BPVS	.510**		
RCPM	.217	.566**	
ToM	.519**	.021	.015
BD	-.041	-.134	.308

*$p < .10$ **$p < .05$ ***$p < .01$ (2-tail)

Additionally, data for each group were examined to determine whether there were differences in chronological and mental age between children who passed versus failed the Sally-Ann ToM test. Means are shown in Tables 5 to 7. A series of independent-samples *t* tests found an effect of chronological age on ToM success in both the autistic group (t (21) = 1.97, $p < .05$ 1-tail) and the Down's syndrome group (t (13) = 2.19, $p < .05$ 1-tail), but no other significant outcomes.

Table 5. Relations between ToM and intellectual maturity in the control group

	Age	*BPVS*	*RCPM*	*BD*
Pass ToM	61.9	56.8	72.0	-
Fail ToM	63.8	57.8	64.5	-

Table 6. Relations between ToM and intellectual maturity in the autistic group

	Age	*BPVS*	*RCPM*	*BD*
Pass ToM	158.0	83.9	101.7	93.6
Fail ToM	131.7	57.2	90.9	90.0

Table 7. Relations between ToM and intellectual maturity in the Down's syndrome group

	Age	*BPVS*	*RCPM*	*BD*
Pass ToM	174.6	52.2	49.8	-
Fail ToM	134.6	50.9	49.2	-

2. The incidence of intellectual versus visual realism

Results for the striped mug task, the teapot task, the cup-and-saucer task, and the cup-and-flowers task were inspected to determine the incidence of intellectual versus visual realism. Every member of the control group produced a full set of recognizable drawings and every member of the Down's syndrome group produced at least some recognizable drawings. However, 4 of 23 participants in the autistic group failed to produce a recognizable depiction in any of the tasks. Of these 4 participants, 1 refused to draw anything other than rabbits, 1 produced only scribble, and 2 fixated on a single attribute of the initial drawing model (for example, portraying the stripes on the striped mug as a series of circles) and proceeded to reproduce this design for all subsequent models. Notably, these 4 participants performed poorly relative to other members of the autistic group on the various measures of intellectual maturity (BPVS: $M = 39$ months, RCPM: $M = 73$ months, BD: $M < 72$ months) and all failed the Sally-Ann ToM test.

For each task, participants were awarded three scores. The first score indicated whether they avoided a commission error for the occluded handle *(omit handle: yes = 1, no = 0)*. The second score indicated whether they included the visible decorative or contextual feature, namely, the stripes on the mug *(include stripes: yes = 1, no = 0)*, the pattern on the teapot *(include pattern: yes = 1, no = 0)*, the saucer in the cup-and-saucer task *(include saucer: yes = 1, no = 0)*, and the flowers in the cup-and-flowers task *(include flowers: yes = 1, no = 0)*. The third score *(depict stripes, depict pattern, depict saucer, depict flowers)* indicated how accurately they depicted the decorative or contextual feature (scores ranging from 0 for 'feature absent' to 1 for 'feature depicted realistically'). In the cup-and-saucer task, for example, depicting the saucer at the base of the cup earned a higher score than depicting the saucer as a circle around the cup. Details of the scoring procedures for indicating the realism of the decorative/contextual features are described in Appendix D.

Tables 8 to 11 present group means for drawing accuracy in the striped mug task, the teapot task, the cup-and-saucer task, and the cup-and-flowers task respectively, in each case derived from those participants who produced the relevant drawing. For each task, the first mean represents the proportion of participants who omitted the occluded handle, the second mean represents the proportion of participants who depicted the visible decorative or contextual feature, and the third mean represents proportional accuracy for depicting the decorative or contextual feature in a realistic way.

Table 8. Group means of proportional drawing accuracy in the striped mug task

	Omit handle	*Include stripes*	*Depict stripes*
Control	.22	.93	.89
Autistic	.65	.89	.84
Down's	.27	.82	.73

Table 9. Group means of proportional drawing accuracy in the teapot task

	Omit handle	*Include pattern*	*Depict pattern*
Control	.22	.41	.35
Autistic	.59	.53	.53
Down's	.31	.62	.42

Table 10. Group means of proportional drawing accuracy in the cup-and-saucer task

	Omit handle	*Include saucer*	*Depict saucer*
Control	.41	.89	.62
Autistic	.59	.94	.66
Down's	.57	.71	.32

Table 11. Group means of proportional drawing accuracy in the cup-and-flowers task

	Omit handle	*Include flowers*	*Depict flowers*
Control	.58	.93	.72
Autistic	.65	.94	.83
Down's	.67	1.0	.57

Table 12 presents the mean results for the four drawing tasks, shown separately for each group. The first mean represents proportional accuracy for omitting the occluded handle across all completed drawings *(omit handle)*, the second mean represents proportional accuracy for depicting the decorative or contextual feature across all completed drawings *(include other)*, and the third mean represents proportional accuracy for portraying the decorative and contextual features realistically *(depict other)*.

Table 12. Group means of proportional drawing accuracy across all four tasks

	Omit handle	*Include other*	*Depict other*
Control	.35	.79	.64
Autistic	.62	.84	.71
Down's	.46	.78	.49

These tables reveal that for all groups and all drawing tasks a sizeable proportion of children incorrectly depicted the occluded handle. There was therefore widespread evidence of intellectual realism. In contrast, participants usually included visible decorative or contextual information in their drawings. The main exception to this trend was the teapot task for which it was common for children to omit the decorative pattern (circle or triangle) above the spout. Such omissions were most apparent for the control group, with only about a third of the sample choosing to depict the pattern.

Finally, Pearson correlation coefficients were calculated to see whether children who avoided commission errors for occluded handles tended also to achieve realistic depictions of (1) decorative details, and (2) contextual information. At least in the latter case, it seems reasonable to expect a positive association between the different aspects of drawing ability because the accurate depiction of contextual information required children to omit certain occluded details, namely, the back view of the saucer and the stalks of the flowers inside the cup (see Appendix D for details). For none of the groups was there found to be a significant positive correlation between mean scores for handle omissions and mean proportional accuracy for depicting the contextual information (control group: $r = -.289$; autistic group: $r = .238$; Down's syndrome group: $r = -.021$, all p values $> .05$). Similarly, there were no significant positive correlations between mean scores for handle omissions and mean proportional accuracy for depicting the decorative features (control group: $r = .021$; autistic group: $r = .187$; Down's syndrome group: $r = -.396$, all p values $> .05$).

In contrast, all groups showed uniformly positive correlations between scores for the occluded handles. For example, omitting the handle in the cup-and-saucer task was reliably correlated with omitting the handle in the cup-and-flowers task (control group: $r = .677$; autistic group: $r = .618$; Down's syndrome group: $r = .828$, all p values $< .01$). Additionally, both the control and the Down's syndrome group showed a positive association between drawing accuracy for the saucer and for the flowers (control group: $r = .504$; Down's syndrome group: $r = .573$, both p values $< .05$). The same trend emerged in the autistic group although it did not quite reach significance ($r = .346$, $p > .05$).

3. Chronological- and mental-age indices of drawing realism

The groups were next compared for the minimum levels of intellectual maturity associated with accurate performance on each drawing measure. This comparison was valid given that the lower limits of ability for both the verbal and non-verbal tests were similar across the groups (BPVS: control group = 36 months, autistic group = 32 months, Down's syndrome group = 34 months; RCPM: all groups = 36 months). Visual realism was evaluated in terms of the avoidance of commission errors for occluded handles, the accurate portrayal of decorative features (the stripes on the mug and the pattern on the teapot), and the accurate portrayal of contextual information (the saucer and the flowers). As discussed in Section B, the realistic portrayal of contextual information required that children omit certain hidden but non-defining details.

Tables 13 to 15 present the results for the control group, the autistic group, and the Down's syndrome group respectively. Each table shows the minimum levels of intellectual maturity associated with success versus failure at (1) correctly omitting all occluded handles *(pass versus fail handle)*, (2) accurately depicting the stripes on the mug *(pass versus fail stripes)*, (3) accurately depicting the pattern on the teapot *(pass versus fail pattern)*, (4) accurately depicting the saucer in the cup-and-saucer task *(pass versus fail saucer)*, and (5) accurately depicting the flowers in the cup-and-flowers task *(pass versus fail flowers)*. For each measure, children were deemed to be successful if they achieved the maximum possible score for drawing realism (see Appendix D).

Table 13. Minimum (and mean) levels of chronological and intellectual maturity associated with aspects of drawing realism in the control group

	Age	*BPVS*	*RCPM*	*BD*
Pass handle	55	39	84	-
(N = 4)	(63.8)	(61.8)	(94.5)	
Fail handle	43	36	36	-
(N = 22)	(62.7)	(56.9)	(65.9)	
Pass stripes	50	36	36	-
(N = 23)	(64.2)	(58.4)	(69.4)	
Fail stripes	43	44	42	-
(N = 4)	(53.8)	(50.0)	(68.3)	
Pass pattern	55	36	42	-
(N = 8)	(59.4)	(47.6)	(63.0)	
Fail pattern	43	38	36	-
(N = 19)	(64.0)	(61.2)	(71.8)	
Pass saucer	55	53	36	-
(N = 2)	(56.0)	(60.5)	(42.0)	
Fail saucer	43	36	36	-
(N = 25)	(63.2)	(56.9)	(71.4)	
Pass flowers	55	41	36	-
(N = 12)	(66.9)	(62.8)	(66.8)	
Fail flowers	43	36	36	-
(N = 15)	(59.2)	(52.6)	(71.2)	

Table 14. Minimum (and mean) scores of chronological and intellectual maturity associated with different aspects of drawing realism in the autistic group

	Age	*BPVS*	*RCPM*	*BD*
Pass handle	118	48	93	74
(N = 7)	(164.4)	(99.7)	(116.6)	(95.7)
Fail handle	88	32	36	74
(N = 8)	(140.5)	(64.1)	(92.3)	(93.3)
Pass stripes	88	32	36	74
(N = 15)	(145.2)	(81.4)	(105.0)	(92.2)
Fail stripes	116	35	36	86
(N = 4)	(143.3)	(50.5)	(84.0)	(92.0)
Pass pattern	96	32	48	74
(N = 9)	(163.0)	(93.6)	(107.3)	(91.3)
Fail pattern	88	33	36	74
(N = 8)	(125.1)	(64.6)	(101.6)	(94.7)
Pass saucer	154	112	111	82
(N = 4)	(179.0)	(123.8)	(126.8)	(107)
Fail saucer	88	32	36	74
(N = 13)	(139.1)	(62.5)	(97.2)	(87.8)
Pass flowers	96	40	72	74
(N = 13)	(147.4)	(88.4)	(115.0)	(96.3)
Fail flowers	88	32	36	74
(N = 5)	(140.8)	(49.2)	(78.0)	(81.0)

Table 15. Minimum (and mean) scores of chronological and intellectual maturity associated with different aspects of drawing realism in the Down's syndrome group

	Age	*BPVS*	*RCPM*	*BD*
Pass handle	102	39	78	-
(N = 1)	(102.0)	(39.0)	(78.0)	
Fail handle	129	42	36	-
(N = 7)	(167.9)	(63.0)	(56.1)	
Pass stripes	118	42	36	-
(N = 7)	(166.3)	(58.7)	(57.9)	
Fail stripes	102	34	36	-
(N = 4)	(113.0)	(49.0)	(46.5)	
Pass pattern	102	39	36	-
(N = 3)	(158.7)	(47.3)	(52.0)	
Fail pattern	107	34	36	-
(N = 10)	(152.7)	(56.0)	(51.3)	
Pass saucer	-	-	-	-
(N = 0)	(-)	(-)	(-)	
Fail saucer	102	34	36	-
(N = 14)	(150.5)	(52.6)	(50.4)	
Pass flowers	112	34	36	-
(N = 3)	(153.0)	(57.7)	(67.0)	
Fail flowers	102	34	36	-
(N = 11)	(150.7)	(51.2)	(45.8)	

As can be seen, at least some participants in each group managed to avoid commission errors for the occluded handles at a young verbal age (i.e., 3 to 4 years). In contrast, such success was linked with a relatively high level of performance on the RCPM test (i.e., equivalent to a mental age of at least 7 years in the control and autistic groups and at least 6.5 years in the Down's syndrome group). Accurate depiction of the stripes on the mug and the pattern on the teapot did not appear to demand high levels of intellectual maturity and the minimum age-equivalent scores associated with visually realistic drawing in this respect were 3 to 4 years for both the BPVS and RCPM tests in all groups. Similarly, minimum verbal and non-verbal mental ages associated with accurate depiction of contextual information were only 3 to 4 years in the control group. In contrast, whereas neither the autistic nor Down's syndrome children found it difficult to accurately portray the flowers, they performed poorly at depicting the saucer. None of the Down's syndrome group drew a realistic saucer and the only autistic children to attain success on this measure had BPVS and RCPM age-equivalent scores of at least 9 years.

Next, data for the striped mug and teapot tasks were inspected in greater detail to determine the mean and minimum levels of intellectual maturity associated with overall visual realism, that is, correct omission of the handle *and* accurate portrayal of the decorative feature. Drawings that were not visually realistic were classified as showing either intellectual realism or symbolism using Barrett and Light's (1976) scheme. Barrett and Light argued that intellectual realism denotes the depiction of all the identifying features of the drawing model whereas symbolism denotes the selective depiction of generic features. Thus, intellectually realistic drawings were those portraying *both* the handle and the decorative attribute whereas symbolic drawings were those portraying *only* the handle.

Tables 16 to 18 show results for the control, autistic, and Down's syndrome groups respectively. The incidence of symbolism, intellectual realism (IR) and visual realism (VR) for the mug task was as follows: control group = 7% vs. 70% vs. 22%; autistic group = 15% vs. 15% vs. 70%; Down's syndrome group = 0% vs. 50% vs. 40%. The incidence of symbolism, intellectual realism and visual realism for the teapot task was as follows: control group = 52% vs. 22% vs. 7%; autistic group = 21% vs. 24% vs. 29%; Down's syndrome group = 29% vs. 15% vs. 8%. Note that some drawings were unclassifiable, either because both the handle and the decorative information were omitted or because the decorative information was included but not accurately portrayed.

Table 16. Minimum (and mean) scores of chronological and intellectual maturity associated with symbolism, IR and VR for the mug and the teapot in the control group.

	Age	*BPVS*	*RCPM*	*BD*
Mug Symbolism	43 (51.5)	50 (50.5)	48 (70.5)	-
Mug IR	50 (62.8)	36 (56.7)	36 (62.3)	-
Mug VR	58 (69.0)	39 (64.6)	84 (94.8)	-
Teapot Symbolism	43 (62.5)	45 (61.1)	36 (67.2)	-
Teapot IR	55 (59.8)	36 (49.7)	42 (61.0)	-
Teapot VR	58 (58.0)	39 (41.5)	54 (69.0)	-

Table 17. Minimum (and mean) scores of chronological and intellectual maturity associated with symbolism, IR and VR for the mug and the teapot in the autistic group.

	Age	*BPVS*	*RCPM*	*BD*
Mug Symbolism	116 (145.0)	41 (63.0)	90 (100.5)	86 (96.0)
Mug IR	88 (108.8)	33 (43.0)	36 (75.0)	74 (80.0)
Mug VR	97 (158.5)	32 (91.9)	48 (113.2)	74 (94.4)
Teapot Symbolism	114 (144.7)	56 (94.0)	72 (112.0)	86 (110.0)
Teapot IR	96 (145.5)	32 (52.3)	48 (85.0)	74 (80.0)
Teapot VR	154 (177.0)	97 (118.4)	96 (120.6)	74 (100.4)

Table 18. Minimum (and mean) scores of chronological and intellectual maturity associated with symbolism, IR and VR for the mug and the teapot in the Down's syndrome group.

	Age	*BPVS*	*RCPM*	*BD*
Mug Symbolism	-	-	-	-
Mug IR	143 (174.3)	42 (61.5)	36 (59.5)	-
Mug VR	118 (118.0)	42 (42.0)	48 (48.0)	-
Teapot Symbolism	112 (138.0)	34 (54.3)	36 (59.0)	-
Teapot IR	186 (187.0)	48 (51.5)	36 (39.0)	-
Teapot VR	102 (102.0)	39 (39.0)	78 (78.0)	-

Tables 16 to 18 reveal that the attainment of overall visual realism tended to be associated with higher levels of verbal and non-verbal ability than non-realistic drawing. However, intellectual realism was not reliably associated with higher levels of verbal and non-verbal ability than symbolism. For both the mug and teapot tasks, all groups showed higher mean RCPM age-equivalent scores for participants who demonstrated symbolism than for participants who demonstrated intellectual realism. For the mug task, BPVS age-equivalent scores were higher for participants who demonstrated symbolism as opposed to intellectual realism in both the autistic group and the Down's syndrome group. For the teapot task, BPVS age-equivalent scores were higher for participants who demonstrated symbolism as opposed to intellectual realism in both the control and the autistic groups.

The analyses described so far have been concerned with identifying the minimum levels of intellectual functioning associated with different kinds of drawing realism. The next set of analyses aimed to examine the broader relations between intellectual maturity and children's drawing skills. Pearson correlation coefficients were calculated to determine the association between the aspects of mean drawing performance described in section 2 (i.e., omissions of the handle, inclusions of decorative or contextual features, and the realism with which decorative or contextual features were depicted), and chronological age, BPVS scores, RCPM scores and, for the clinical groups, BD scores. The correlation coefficients were calculated separately for each group and the results are presented in Tables 19 to 21.

Table 19. Correlations between intellectual maturity and mean drawing accuracy: Control group

	Age	*BPVS*	*RCPM*	*BD*
Omit handle	.066	.203	.464**	-
Include other	.162	-.081	-.260	-
Depict other	.375**	.167	-.199	-

*$p < .10$ **$p < .05$ ***$p < .01$ (2-tail)

Table 20. Correlations between intellectual maturity and mean drawing accuracy: Autistic group

	Age	*BPVS*	*RCPM*	*BD*
Omit handle	.251	.501**	.423*	.219
Include other	.321	.334	-.073	.026
Depict other	.569**	.537**	.251	.257

*$p < .10$ **$p < .05$ ***$p < .01$ (2-tail)

Table 21. Correlations between intellectual maturity and mean drawing accuracy: Down's syndrome group

	Age	*BPVS*	*RCPM*	*BD*
Omit handle	-.475	-.274	-.297	-.041
Include other	.108	.170	.066	.141
Depict other	.663**	-.006	.307	.323

*$p < .10$ **$p < .05$ ***$p < .01$ (2-tail)

Tables 19 to 21 reveal group differences in the relations between the various measures of intellectual maturity and children's ability to avoid commission errors for the occluded handles. Whereas drawing accuracy on this measure was best predicted by the RCPM scores in the control group it correlated more highly with BPVS scores in the autistic group. In the Down's syndrome group, by contrast, none of the tests of cognitive ability were linked with visual realism on this measure. Instead, there was a tendency for the more able (and older) participants to make *more* commission errors than the less able (and younger) participants.

A more consistent picture emerges when considering predictors of the ability to portray decorative or contextual features in a realistic way, with all three groups showing a significant positive correlation between chronological age and success on this measure. The autistic group additionally showed a significant positive correlation between BPVS scores and the ability to depict decorative and contextual information. Whereas the same trend failed to appear in the control group, inspection of the individual task results suggests a reason for this discrepancy. For the control group, BPVS scores showed a positive correlation with the depiction of decorative/contextual details in both the cup-and-saucer task ($r = .541, p < .01$) and the cup-and-flowers task ($r = .493, p < .05$). In contrast, for the teapot task, superior depiction of the decorative feature was *negatively* associated with BPVS scores ($r = -.498, p < .05$). When the preceding correlations were recalculated for the control group to exclude the teapot task, 'depict other' scores showed a reliable association with both BPVS scores ($r = .527, p < .01$) and chronological age ($r = .510, p < .01$).

To determine whether drawing skills were related to performance on the Sally-Ann ToM test, measures of drawing accuracy averaged across all tasks were compared for children who passed versus failed the test, separately for each group. Results are shown in Tables 22 to 24. For each table, the first mean represents proportional accuracy for omitting the occluded handles *(omit handle)*, the second mean represents proportional accuracy for including the decorative and contextual features *(include other)*, and the third mean represents proportional accuracy for portraying the decorative and contextual features realistically *(depict other)*.

Table 22. Mean proportional drawing accuracy in the control group as a function of performance on the Sally-Ann ToM test.

	Omit handle	*Include other*	*Depict other*
Pass ToM	.33	.76	.65
Fail ToM	.40	.82	.63

Table 23. Mean proportional drawing accuracy in the autistic group as a function of performance on the Sally-Ann ToM test.

	Omit handle	*Include other*	*Depict other*
Pass ToM	.84	.92	.78
Fail ToM	.43	.77	.65

Table 24. Mean proportional drawing accuracy in the Down's syndrome group as a function of performance on the Sally-Ann ToM test.

	Omit handle	*Include other*	*Depict other*
Pass ToM	.30	.77	.53
Fail ToM	.53	.79	.47

For each group, independent-samples t tests were carried out to compare the means of the 'pass' versus 'fail' groups on each measure (controlling the type-1 error rate across the three comparisons at $p = .05$). Whereas there were no significant effects of ToM in the control or Down's syndrome groups, participants in the autistic group who passed the ToM test performed significantly better at omitting occluded handles than those who failed the ToM test (t (16) = 2.46, $p < .01$ 1-tail).

4. The effects of functional context on children's commission errors

Another aim of the present investigation was to see whether children's ability to avoid a commission error for the occluded handle of a mug or cup was affected by the functional context of the model. To this end, results were compared for the mug task (i.e., no context), the cup-and-saucer task (i.e., appropriate context), and the cup-and-flowers task (i.e., misleading context). It was predicted that if children were concerned with whether the contextual feature conveyed accurate information about the identity of the model then they should be least likely to make commission errors in the cup-and-saucer task and most likely to make commission errors in the cup-and-flowers task.

This prediction was not confirmed for the control group. Although the incidence of drawing realism varied markedly across the three tasks, the differences were not in the expected direction and accuracy was lowest in striped mug task, at an intermediate level in the cup-and-saucer task, and highest in the cup-and-flowers task. Of the total sample, the proportion of children that omitted the handle was .22 in the striped mug task, .41 in the cup-and-saucer task, and .58 in the cup-and-flowers task (see Tables 5, 7, & 8). Of 26 children who drew all three mug/cups, the proportion that omitted the handle was .23 in the striped mug task ($SD = .43$), .39 in the cup-and-saucer task ($SD = .50$) and .58 in the cup-and-flowers task ($SD = .50$). These results were analysed using Cochran's Q test for nominal data. It was found that the frequency of commission errors differed reliably across the three drawing tasks, Cochran $Q = 13.56$, $df = 2$, $p < .01$.

The same trend was evident in the Down's syndrome group. Of the total sample, the proportion of children that omitted the handle was .27 in the striped mug task, .57 in the cup-and-saucer task, and .67 in the cup-and-flowers task (see Tables 5, 7, & 8). Of 9 children who drew all three mug/cups, the proportion that omitted the handle was .22 in the striped mug task ($SD = .44$), .56 in the cup-and-saucer task ($SD = .53$) and .67 in the cup-and-flowers task ($SD = .50$). Again, Cochran's Q test found that the functional context reliably affected the frequency of commission errors, Cochran $Q = 6.50$, $df = 2$, $p < .05$.

In contrast, there was no effect of functional context on the likelihood that the autistic group achieved visual realism. Of the total sample, the proportion of children that omitted the handle was .65 in the striped mug task, .59 in the cup-and-saucer task, and .65 in the cup-and-flowers task (see Tables 5, 7, & 8). Of 15 children who drew all three mug/cups, the proportion that omitted the handle was .67 in the striped mug task (SD = .49), .53 in the cup-and-saucer task (SD = .52) and .67 in the cup-and-flowers task (SD = .49). When Cochran's Q test was applied to the latter data it found no significant effect of task on drawing accuracy, Cochran $Q = 2.00$, $df = 2$, $p > .05$.

Data were further examined to determine whether children's sensitivity to contextual information depended on their intellectual maturity. Accordingly, the frequency of commission errors for the occluded handle in the various mug/cup tasks was compared for children with high versus low scores on each measure of intellectual maturity (i.e., a median split), separately for each group.

In the control group, there was a reliable increase in commission errors from the striped mug task to the cup-and-saucer task to the cup-and-flowers task in all cases. Thus, the trend appeared for children with low BPVS scores (2 vs. 2 vs. 6; Cochran $Q = 8.00$, $df = 2$, $p < .05$), high BPVS scores (4 vs. 8 vs. 9; Cochran $Q = 8.40$, $df = 2$, $p < .05$), low RCPM scores (0 vs. 3 vs. 5; Cochran $Q = 7.60$, $df = 2$, $p < .05$), and high RCPM scores (6 vs. 7 vs. 10; Cochran $Q = 6.50$, $df = 2$, $p < .05$). Similarly, the effect was evident whether children failed the Sally-Ann test (2 vs. 5 vs. 6; Cochran $Q = 6.50$, $df = 2$, $p < .05$) or passed the Sally-Ann test (4 vs. 5 vs. 9; Cochran $Q = 8.40$, $df = 2$, $p < .05$).

Similarly, sensitivity to functional context was evident in the Down's syndrome group for both high and low levels of intellectual maturity, although significantly so only for participants who attained low RCPM scores (1 vs. 4 vs. 4; Cochran $Q = 6.00$, $df = 2$, $p < .05$) or low Block Design scores (1 vs. 4 vs. 4; Cochran $Q = 6.00$, $df = 2$, $p < .05$). There was a marginal effect for children with high BPVS scores (0 vs. 2 vs. 3; Cochran $Q = 4.67$, $df = 2$, $p < .10$) and for those who failed the Sally-Ann test (1 vs. 3 vs. 4; Cochran $Q = 4.67$, $df = 2$, $p < .10$).

In the autistic group, the manipulation of functional context was ineffective in producing a change in the frequency of commission errors regardless of whether children showed inferior or superior performance on any of the measures of intellectual maturity (low BPVS scores: 3 vs. 2 vs. 4; high BPVS scores: 7 vs. 6 vs. 6; low RCPM scores: 3 vs. 2 vs. 3; high RCPM scores: 7 vs. 6 vs. 7; fail Sally-Ann test: 4 vs. 3 vs. 4; pass Sally Ann test: 6 vs. 5 vs. 6; low Block Design scores: 4 vs. 3 vs. 4; high Block Design scores: 6 vs. 5 vs. 6).

5. The Draw-A-Person Test

The Draw-A-Person test was completed by all participants in the control group, all participants in the Down's syndrome group, and 17 of 23 participants in the autistic group. Drawing maturity was scored using the Goodenough-Harris Draw-A-Person test critieria (Harris, 1964). A summary of these criteria is presented in Appendix E. A repeated-measures ANOVA found that the Draw-A-Person age-equivalent scores for the control group ($M = 62.4$ months, $SD = 17.3$; mean standardized score = 107.5) were in line with their chronological age, $F(1, 26) = .004, p > .05$, their BPVS age-equivalent scores, $F(1, 26) = 2.64, p > .05$, and their RCPM age-equivalent scores, $F(1, 26) = 1.66$, $p > .05$. In contrast, Draw-A-Person age-equivalent scores for the autistic group ($M =$ 97.4 months, $SD = 52.5$; mean standardized score = 81.2) were significantly impaired relative to their chronological age, $F(1, 14) = 10.63, p < .01$, and significantly superior to their BPVS age-equivalent scores, $F(1, 14) = 5.56, p < .05$. However, there was no significant deviation from either their RCPM age-equivalent scores, $F(1, 14) = .079, p >$ .05 or their Block Design age-equivalent scores, $F(1, 14) = 1.72, p > .05$. Finally, Draw-A-Person scores in the Down's syndrome group ($M = 46.0$ months, $SD = 15.8$; mean standardized score = 62.5) were significantly impaired relative to their chronological age, $F(1, 14) = 95.01, p < .001$, but did not differ reliably from either their BPVS age-equivalent scores, $F(1, 14) = 1.51, p > .05$ or their RCPM age-equivalent scores, $F(1, 14) = .480, p > .05$.

Data were also examined to determine whether children's drawing maturity as gauged by the Draw-A-Person test was positively correlated with their chronological and mental age. As can be seen in Table 25, Draw-A-Person scores showed reliable positive associations with BPVS scores in all three groups. These correlations held up even when the effects of age were partialled out (control group: $r = .357, p < .10$ 2-tail; autistic group: $r = .519, p < .05$ 2-tail; Down's syndrome group: $r = .582, p < .05$ 2-tail). Similarly, controlling for the effects of age, there was a reliable correlation between

Draw-A-Person scores and RCPM performance in the Down's syndrome group ($r = .462$, $p < .10$ 2-tail).

Table 25. Correlations between Draw-A-Person scores and the various measures of intellectual maturity

	Age	*BPVS*	*RCPM*	*BD*
Control	.512***	.550***	.225	–
Autistic	.310	.544**	.400	.397
Down's	-.004	.499**	.450*	.314

*$p < .10$ **$p < .05$ ***$p < .01$ (2-tail)

Additionally, Draw-A-Person scores were examined as a function of performance on the Sally-Ann ToM test. Independent-samples t tests found no reliable difference in Draw-A-Person age-equivalent scores between children who passed versus failed the test in either the control group (63.5 versus 60.6 months; $t\ (25) = .42, p > .05$ 2-tail) or the Down's syndrome group (44.4 versus 46.8 months; $t\ (13) = -.27, p > .05$ 2-tail). In contrast, among the autistic group, children who passed achieved significantly greater Draw-A-Person scores than those who failed (130.3 versus 74.4 months; $t\ (15) = 2.49, p < .05$ 2-tail).

Next, to see whether drawing maturity in the Draw-A-Person test was associated with performance in the various object-drawing tasks, correlations were calculated between the Draw-A-Person scores and measures of drawing realism averaged across the striped mug task, the teapot task, the cup-and-saucer task, and the cup-and-flowers task. These measures were the same as described in Section B, namely, 'omit handle' scores, 'include other' scores, and 'depict other' scores. The results for each group are shown in Table 26.

Table 26. Correlations between Draw-A-Person scores and mean drawing accuracy for the object-drawing tasks

	Omit handle	*Include other*	*Depict other*
Control	.249	.073	.207
Autistic	.588**	.301	.387
Down's	.038	-.081	.066

*$p < .10$ **$p < .05$ ***$p < .01$ (2-tail)

As can be seen, Draw-A-Person scores were positively associated with competence in the object-drawing tasks only for the autistic group and only in relation to children's ability to avoid commission errors for the hidden handles. This pattern of results was replicated even when the effects of age were partialled out (control group: $r = .251, p > .10$ 2-tail; autistic group: $r = .557, p < .05$ 2-tail; Down's syndrome group: $r = .042, p > .10$ 2-tail).

6. Matched group analyses: Control versus autistic children

The next set of analyses compared the incidence of drawing realism in the control and autistic groups using a subset of participants matched as closely as possible on mental age. Given that the groups were selected to produce mental-age distributions with similar means and variability, it was additionally of interest to re-examine the relations between intellectual maturity and drawing accuracy in each case. Because it proved impossible to achieve a reasonable sample size by attempting to match the groups simultaneously on verbal and non-verbal mental age, analyses were conducted first on groups matched for BPVS scores and then for groups matched on RCPM scores.

Groups matched on BPVS scores

Two groups of 11 participants each were created by matching control and autistic children for their BPVS performance on a one-to-one basis (i.e., matched to within 6 months). An independent-samples *t*-test confirmed that the groups failed to differ significantly in their mean BPVS age-equivalent scores (control $M = 50.8$, autistic $M = 50.1$; $t\ (20) = .12, p > .05$). Similarly, Levene's test for equality of variances found no significant group difference (control $SD = 12.2$, autistic SD = 15.0; $F = .114, p > .05$). The autistic children attained significantly higher scores than the control group for both chronological age (131.9 versus 58.1; $t\ (20) = -7.46, p < .05$) and RCPM age-equivalent performance (94.1 versus 70.6 $t\ (20) = -2.00, p < .05$). However, a test of the difference between proportions found that their performance on the Sally-Ann ToM test was marginally worse (.27 versus .64; $z = 1.74$, $p < .08$ 2-tail). Pearson's correlation coefficients calculated between the different measures of intellectual maturity found that age was positively associated with RCPM scores in the control group ($r = .652$, $p < .05$) and that RCPM scores were positively associated with BD scores in the autistic group ($r = .697$, $p < .05$).

The question of whether the matched groups differed in drawing realism was addressed by comparing their mean proportional accuracy on each of the drawing measures, controlling the type 1 error rate at .05 across the entire set of comparisons. No significant differences emerged either for the occluded handles (control $M = .45$, autistic $M = .45$), the stripes on the mug (control $M = .86$, autistic $M = .77$), the pattern on the teapot (control $M = .50$, autistic $M = .30$), the saucer (control $M = .43$, autistic $M = .54$), or the flowers (control $M = .64$, autistic $M = .73$). Additional analyses comparing the groups for their overall visual realism at depicting the striped mug and the teapot likewise produced no significant outcomes (mug: control $M = .30$, autistic $M = .50$; t (20) = -1.05; teapot: control $M = .20$, autistic $M = .00$; t (20) = 1.42, both p values > .025). These findings confirm the conclusion drawn earlier in relation to the results for the entire sample that the autistic children showed no precocious drawing realism.

Nevertheless, when the results of the individual mug/cup drawing tasks were compared it was again found that the null effect of group in relation to overall handle omissions concealed a task-dependent group difference. In the control group, there was a reliable increase in commission errors from the mug task ($M = .27$) to the cup-and-saucer task ($M = .36$) to the cup-and-flowers task ($M = .82$), Cochran $Q = 10.33$, $df = 2$, $p < .01$. In contrast, this trend failed to emerge in the autistic group (mug $M = .50$, cup-and-saucer $M = .36$, cup-and-flowers $M = .40$), Cochran $Q = 2.00$, $df = 2$, $p > .05$.

Next, correlation coefficients were calculated to determine the relations between intellectual maturity and drawing realism. In the control group, avoidance of commission errors for occluded handles showed a significant positive relation with RCPM scores ($r = .587$, $p = .05$) and there was a reliable *negative* relation between BPVS scores and accuracy for portraying the pattern on the teapot ($r = -.796$, $p < .01$). In the autistic group, there were no significant correlations between any of the measures of intellectual maturity and the measures of drawing realism. The highest positive association was between mean accuracy for handle omissions and RCPM scores ($r = .224$, $p > .05$).

Finally, the groups were compared for their drawing maturity in the Draw-A-Person test. Although age-equivalent scores were higher in the autistic group than the control group (autistic $M = 82.8$, $SD = 43.6$; control $M = 59.5$, $SD = 13.0$), the difference was not reliable, $t\,(19) = -1.70$, $p > .05$). In the control group, Draw-A-Person scores showed moderate but non-significant positive correlations with chronological age ($r = .367$), BPVS scores ($r = .375$), RCPM scores ($r = .378$), and mean drawing realism for the occluded handles ($r = .425$). In the autistic group, Draw-A-Person scores showed moderate but non-significant positive correlations with RCPM scores ($r = .398$), BD scores ($r = .517$) and mean drawing accuracy for the occluded handles ($r = .361$).

Groups matched on RCPM scores

Two groups of 10 participants each were created by matching control and autistic children according to their RCPM age-equivalent scores on a one-to-one basis (i.e., to within 6 months). An independent samples *t*-test confirmed that the groups failed to differ significantly in their mean RCPM age-equivalent scores (control $M = 84.9$, autistic $M = 87.3$; $t\,(18) = -.20, p > .05$). Similarly, Levene's test for equality of variances found no significant group difference (control $SD = 26.0$, autistic $SD = 27.2$; $F = .043, p > .05$). The autistic children attained significantly higher scores than the control group for chronological age (145.3 versus 64.6; $t\,(18) = -6.87, p < .05$) whereas a test of the difference between proportions showed that they performed marginally worse on the Sally-Ann ToM test (control $M = .80$, autistic $M = .40$; $z = 1.83, p = .06$ 2-tail). Although there was no significant group difference in BPVS age-equivalent scores (control $M = 62.8$, autistic $M = 60.2$, $t\,(18) = .25, p > .05$), Levene's test for equality of variances revealed significantly greater standard deviation in the autistic sample (control $SD = 13.4$, autistic $SD = 30.1$; $F = 5.483, p < .05$).

Pearson's correlation coefficients calculated between the different measures of intellectual maturity found that age was significantly associated with BPVS scores in the control group ($r = .637, p < .05$) and that RCPM scores were significantly associated with BD scores in the autistic group ($r = .696, p < .05$).

A series of t tests was used to compare the performance of the groups on the various measures of drawing realism, controlling the overall type-1 error rate at .05. There were no significant group differences in mean accuracy for avoiding commission errors for the occluded handles (control $M = .45$, autistic $M = .48$), or for depicting either the stripes on the mug (control $M = .90$, autistic $M = .75$), the saucer (control $M = .73$, autistic $M = .68$) or the flowers (control $M = .80$, autistic $M = .77$). However, the autistic group significantly outperformed the control group at depicting the pattern on the teapot (control $M = .05$, autistic $M = .56$; $t\,(18) = -2.90$, $p = .01$). When overall visual realism was evaluated for the striped mug and the teapot, the groups achieved similar results (striped mug: control $M = .50$, autistic $M = .50$; teapot: control $M = 0$, autistic $M = .10$, both p values $> .025$)

Despite the fact that the groups failed to differ significantly in the overall frequency of commission errors in the mug/cup tasks, however, there was again evidence that only the control group were sensitive to the contextual information. There was a marginally significant effect of task in the control group (mug $M = .40$, cup-and-saucer $M = .50$, cup-and-flowers $M = .70$; Cochran $Q = 4.67$, $df = 2$, $p < .10$) but not the autistic group (mug $M = .44$, cup-and-saucer $M = .33$, cup-and-flowers $M = .55$; Cochran $Q = 2.00$, $df = 2$, $p > .10$).

For neither group were there any significant correlations between the measures of drawing accuracy and intellectual maturity. Nevertheless, the control group showed a marginally significant negative relation between BPVS scores and accuracy for portraying the pattern on the teapot ($r = -.589$, $p < .10$ 2 tail).

Finally, data were examined to determine whether the groups differed in their mean levels of drawing maturity in the Draw-A-Person test. Although age-equivalent scores were higher in the autistic than the control group (autistic $M = 86.7$, $SD = 52.2$; control $M = 64.8$, $SD = 20.9$), the difference was not significant, $t\,(17) = -1.22$, $p > .05$). In the control group, Draw-A-Person scores showed a marginally significant positive correlation with BPVS scores ($r = .580$, $p < .10$). In the autistic group, Draw-A-Person scores showed significant positive correlations with chronological age ($r = .659$, $p = .05$) BPVS scores ($r = .713$, $p < .05$) and mean accuracy at portraying occluded handles ($r = .757$, $p < .05$).

7. The effects of gender on children's drawing skills: The control group

In line with the general population of autism sufferers, the present sample of autistic children comprised mainly boys. The final set of analyses therefore examined the results for the control group separately for males (N = 16) and females (N = 11) to see whether the gender imbalance within the autistic sample could account for, first, their insensitivity to functional context, and second, their superior depiction of the pattern on the teapot.

When the results of the individual mug/cup drawing tasks were compared for each gender there was found to be a task-dependent shift in the frequency of commission errors for *both* the boys and the girls. For the boys, drawing realism for the occluded handle improved reliably from the mug task ($M = .27$) to the cup-and-saucer task ($M = .40$) to the cup-and-flowers task ($M = .60$), Cochran $Q = 7.60$, $df = 2$, $p < .05$. For the girls, there was likewise a reliable decrease in commission errors from the mug task ($M = .18$) to the cup-and-saucer task ($M = .36$) to the cup-and-flowers task ($M = .55$), Cochran $Q = 6.00$, $df = 2$, $p < .05$.

Drawing performance for the pattern on the teapot was similarly unaffected by gender. Boys and girls did not differ in their propensity to include the pattern in their drawing (boys $M = .38$, girls $M = .45$; $t\,(25) = -.40$, $p > .05$ 2-tail), nor in the realism with which they depicted the pattern (boys $M = .69$, girls $M = .73$; $t\,(25) = -.11$, $p > .05$ 2-tail). Importantly, *both* groups showed a negative relation between BPVS scores and accuracy for portraying the pattern on the teapot (boys $r = -.604$, $p < .05$ 2-tail; girls $r = -.487$, $p < .10$ 2-tail).

Additional analyses found that, among the control group, boys and girls failed to differ significantly in their chronological age (boys $M = 63.7$, girls $M = 61.1$; $t\,(25) = .66$, $p > .05$), their mean BPVS age-equivalent scores (boys $M = 56.9$, girls $M = 57.5$; $t\,(25) = -.12$, $p > .05$) or their mean RCPM age-equivalent scores (boys $M = 64.7$, girls $M = 75.8$; $t\,(25) = -1.25$, $p > .05$). However, a test of the difference between proportions found that marginally fewer boys than girls passed the Sally-Ann ToM test (.50 versus .82; $z = -1.69$, $p < .10$ 2-tail). Pearson's correlation coefficients calculated between the different measures of intellectual maturity found that age was positively associated with BPVS scores for the boys ($r = .729, p < .01$) and with RCPM scores for the girls ($r = .610, p < .05$). In neither group was there a reliable difference in verbal or non-verbal age between children who passed the Sally-Ann ToM test and those who failed the Sally-Ann ToM test (all p values $> .05$ 2-tail).

Drawing realism was also compared for boys versus girls in terms of mean proportional accuracy on each of the drawing measures, controlling the type-1 error rate at .05 across all comparisons. For the object-drawing tasks, no significant gender difference emerged either for the depiction of occluded handles (boys $M = .36$, girls $M = .34$), the depiction of decorative and contextual details (boys $M = .80$, girls $M = .77$), or the realism with which decorative and contextual details were depicted (boys $M = .62$, girls $M = .68$). Similarly, boys and girls achieved equivalent levels of performance in the Draw-A-Person test (boys $M = 67.1$, girls $M = 55.6$).

Examination of the relations between intellectual maturity and drawing realism found that mean proportional accuracy for depicting occluded handles was reliably associated with RCPM scores for the boys ($r = .528, p < .05$ 2-tail) and showed a trend in the same direction for the girls ($r = .441, p > .10$ 2-tail). Mean proportional accuracy for the realistic depiction of decorative and contextual details, excluding the results for the pattern on the teapot, showed a reliable association with BPVS scores for *both* the boys ($r = .486, p = .05$ 2-tail) and the girls ($r = .609, p < .05$ 2-tail). For the boys, it was additionally related to chronological age ($r = .654, p < .01$ 2-tail). For the boys, Draw-A-Person scores showed a significant positive correlation with chronological age ($r = .510$,

$p < .05$ 2-tail) and a marginal positive correlation with BPVS scores ($r = .447$, $p < .10$ 2-tail). For the girls, Draw-A-Person scores showed a significant positive correlation only with BPVS scores ($r = .613$, $p < .05$ 2-tail). For neither group were Draw-A-Person scores associated with any of the other measures of drawing skill. Similarly, for neither group did any aspect of drawing performance differ significantly between children who passed versus failed the Sally-Ann ToM test (all p values $> .05$ 2-tail).

Chapter Four

DISCUSSION

The present study investigated the relations between intellectual maturity and drawing ability in autistic children (unselected for gifted artistic ability), children making normal developmental progress, and Down's syndrome children. Intellectual maturity was assessed in terms of verbal age (the British Picture Vocabulary Scale), non-verbal age (Raven's Coloured Progressive Matrices), the understanding of false belief (the Sally Ann test) and, for the clinical groups, central coherence (the Block Design sub-test of the WISC). Children's drawing ability was evaluated by asking them to portray a series of inanimate objects (i.e., a striped mug, a teapot with a pattern above its spout, a cup and saucer, and a cup with flowers inside it), all positioned with the handle hidden from view. Interest centred on children's ability to avoid commission errors for the occluded handle, to accurately portray visible decorative features (i.e., the stripes on the mug and the pattern on the teapot), and to accurately portray contextual details (i.e., the saucer and the flowers). Results for each group were examined to determine, first, the minimum verbal and non-verbal mental ages associated with success on each measure, and second, the strength of the relations between the various measures of cognitive ability and drawing realism. Additional tests were conducted to see whether the groups differed in the extent to which their drawing realism for a mug or cup with an occluded handle varied according to the functional context of the model. Finally, children's drawing maturity was assessed using the Goodenough-Harris Draw-A-Person test. Participants were asked to draw a self-portrait, with their productions being scored in terms of the details and scaling expected for a generalized drawing of a person (Harris, 1964).

1. Drawing development in autistic versus non-autistic children

Previous comparisons of drawing development between autistic and non-autistic children used drawing models that lacked decorative and contextual information (Charman & Baron-Cohen, 1993; Eames & Cox, 1994). In the present research, the inclusion of such information allowed a more rigorous evaluation of possible group differences in the links between intellectual maturity and drawing realism. Despite this novel approach, however, the results were consistent with past investigations in providing no evidence of precocious drawing skills in autism. The minimum mental age associated with the correct omission of all four occluded handles was marginally lower in the control group than the autistic group for both verbal and non-verbal measures of intellectual maturity (BPVS: 39 vs. 48 months; RCPM: 84 vs. 93 months). Similarly, the control group outperformed the autistic group at depicting decorative and contextual details. For both groups, the minimum BPVS age-equivalent scores for accurate depiction of the stripes on the mug, the pattern on the teapot, and the flowers in the teacup were either at or near the bottom of the range. However, the minimum BPVS age-equivalent score associated with success at depicting the saucer was substantially lower in the control group than the autistic group (53 vs. 112 months). Additionally, the autistic children lagged behind the control children in the minimum RCPM age-equivalent scores linked with drawing realism for both the saucer and the flowers (saucer: 36 vs. 111 months; flowers: 36 vs. 72 months). These findings strongly contradict the suggestion that autistic children make faster developmental progress in relation to their transition from intellectual to visual realism.

The conclusion that the autistic group were developing their drawing skills at the normal rate is bolstered when considering the results for the Down's syndrome group. Similar to the control group, the Down's syndrome children at least matched the autistic children in the minimum levels of intellectual maturity associated with most measures of drawing realism. Indeed, the minimum verbal and non-verbal ages associated with the correct omission of all four occluded handles were lower in the Down's syndrome group than the autistic group (BPVS: 39 vs. 48 months; RCPM: 78 vs. 93 months), as was the minimum non-verbal age associated with accurate depiction of the flowers (36 vs. 72 months). Like the autistic group, however, the Down's syndrome children found it difficult to achieve an accurate portrayal of the saucer and none of the participants were successful on this measure.

Results of the mug and teapot tasks were further inspected to determine the prevalence of symbolism versus intellectual realism in each group. According to Barrett and Light (1976), symbolism corresponds to generic depictions of objects of the kind described by Luquet (1927) whereas intellectual realism corresponds to drawings that include all attributes necessary to identify the specific model, either generic or non-generic. Examples of both types of non-realistic drawings were uncovered in all three groups. Thus, children sometimes indicated the *general semantic class* of the model (e.g., by drawing a plain teapot) and other times its *particular identity* (e.g., by drawing a teapot with a pattern above its spout). In contrast to Barrett and Light's suggestion that symbolism represents an earlier stage of drawing development than intellectual realism, there were no strong indications that symbolic drawings were associated with lower levels of intellectual maturity than intellectually real drawings. Instead, whether children tended towards symbolism or intellectual realism was influenced by the drawing model rather than intellectual maturity, at least in the non-autistic groups. Overall, there was little difference in the relative incidence of symbolism versus intellectual realism between the autistic and non-autistic children. For both the developmentally normal and Down's syndrome groups, however, intellectual realism was more prevalent than symbolism in the striped mug task whereas the reverse was true in the teapot task.

2. Relations between intellectual maturity and drawing realism

In all groups, the ability to avoid commission errors for the occluded handles depended on a relatively high level of non-verbal ability. The minimum RCPM age-equivalent score associated with success at omitting all four handles was 84 months in the control group, 93 months in the autistic group, and 78 months in the Down's syndrome group. In contrast, the equivalent BPVS age-equivalent scores were 39 months in the control group, 48 months in the autistic group, and 39 months in the Down's syndrome group. These results conform to those reported by Charman and Baron-Cohen (1993). In their study, children who showed visual realism differed from children who failed to show visual realism mainly in their non-verbal age, with there being little difference between the groups in terms of verbal age. Charman and Baron-Cohen noted from their data that drawing realism was associated with RCPM age-equivalent scores of at least 74 months in the control group and at least 66 months in the autistic group.

When correlation coefficients were calculated between the various measures of intellectual maturity and children's drawing accuracy for the occluded handles, different patterns emerged across the groups. In the control group, success at avoiding commission errors for the occluded handles was linked only with RCPM scores. In the autistic group, this variable showed positive correlations with both RCPM scores and BPVS scores. In the Down's syndrome group, in contrast, there was no association between intellectual maturity and children's success at avoiding commission errors. The failure of intellectual maturity to predict drawing performance in the Down's syndrome group reflects the fact that, while accurate depiction of all four occluded handles depended a relatively high level of non-verbal ability, commission errors were prevalent among both high and low achievers on the various skills' tests. A similar phenomenon was reported by Charman and Baron-Cohen (1993). Whereas participants in their study who attained visual realism all had a relatively high non-verbal age, those who failed to attain visual realism represented a wide range of abilities. Charman and Baron-Cohen concluded that a reasonably advanced non-verbal ability is a necessary but insufficient condition for visually realistic drawing.

Charman and Baron-Cohen (1993) suggested that the reason why drawing realism depends on non-verbal rather than verbal age is because drawing is a visuospatial skill. However, the present investigation found that *neither* verbal nor non-verbal capabilities were strongly predictive of drawing accuracy for decorative and contextual details. Instead, with the exception of the saucer in the cup-and-saucer task, participants in all groups achieved an accurate depiction of the decorative and contextual information at low levels of verbal and non-verbal maturity. Similarly, participants in the control group achieved visual realism for the saucer in the cup-and-saucer task with relatively poor performance on the skills' tests although success was better predicted by verbal than non-verbal age. Cognitive indices of drawing accuracy for the saucer could not be evaluated in the Down's syndrome group because none of the children achieved visual realism on this measure. Among the autistic group, drawing accuracy for the saucer was linked with high levels of attainment on *both* the BPVS and RCPM tests.

Whereas successful depiction of decorative and contextual attributes did not appear to demand high levels of intellectual maturity on the whole, Pearson correlation coefficients revealed significant, positive relations with chronological age in all three groups. The autistic group additionally showed a significant positive association between their BPVS scores and drawing accuracy for decorative and contextual information, a pattern that also emerged in the control group with the exception of the pattern on the teapot. Consistent with this evidence that different skills underpinned children's portrayal of the occluded handles and their portrayal of other kinds of features, correlation analyses found no association between the different measures of drawing ability. In none of the groups was children's ability to avoid commission errors for occluded handles predicted by their accuracy at depicting either the decorative or contextual attributes. This was despite the fact that the system for scoring children's portrayal of contextual information awarded higher scores to those participants who avoided depicting hidden details, namely, the rear of the saucer and the stalks of the flowers inside the cup. In contrast, children's accuracy at depicting the occluded handles was positively correlated across tasks and, similarly, their ability to accurately portray the saucer in the cup-and-saucer task was positively correlated with their ability to accurately portray the flowers in the cup-and-flowers task.

These findings raise the question of why different aspects of children's drawing skills were dissociated. Possibly, the answer lies in the extent to which different drawing tasks demand sustained visual attention for producing visual realism. Sutton and Rose (1998) suggested that whether young children avoid a commission error when attempting to depict a cup or mug with an occluded handle depends on how effectively they attend to the model. They studied the looking habits of 6 to 8 year olds who were asked to draw a mug with its handle hidden from view and found that children who drew realistically showed a greater overall looking time and more frequent glances at the model than children who included the handle. In contrast, the latter group tended to glance at the model only at the beginning of the drawing process. Sutton and Rose's findings suggest that, in the present study, sustained attention was important for the accurate depiction of an occluded handle but not for the accurate depiction of decorative and contextual attributes. Assuming this to be true, the reason why children's ability to avoid commission errors was linked with higher RCPM scores might be that superior performance on the RCPM test depends on the efficient allocation of attention. That is, participants with superior powers of visual attention might have found it easier both to detect critical visual information that allowed them to solve the matrices problems and to look long enough at the drawing models to produce a realistic depiction of them.

Conversely, whether children achieved visual realism for decorative and contextual features might have depended more on their memory capabilities, knowledge and motor skills than visual attention. The positive association between chronological age and the portrayal of such features could thus reflect the fact that there are improvements in cognitive and motor processes as children grow older. Similarly, the contribution of verbal ability to the accurate depiction of decorative and contextual details, at least in the control and autistic groups, could be explained by the idea that language development depends to some extent on memory and learning. Another reason why verbal skills were correlated with aspects of drawing realism might be because of their pivotal role in planning and problem solving during early childhood (i.e., the idea of *private speech,* Vygotsky, 1986). Consistent with this view, evidence implicates an important role of strategies in drawing development (Thomas, 1995).

On the other hand, the fact that the control group showed a significant, *negative* association between BPVS scores and their depiction of the pattern on the teapot seems incongruent with the notion that verbal ability is linked with planning skills. That is, it is unclear why superior verbal age was not associated with *greater* competence on this measure. One possibility is that verbal capabilities influence children's ability to reason about the problems of portraying containment. Taylor and Bacharach (1982) found that young children were reluctant to depict a decorative feature when it was positioned within the boundaries of another object. They suggested that children assumed this arrangement would be perceived by a naïve observer as representing one object inside another. Participants in the control group, at least those with superior verbal intelligence, might thus have feared that depicting the pattern would falsely give the impression of an object *inside* the teapot.

In addition to verbal and non-verbal age, participants were assessed for their understanding of false belief using the Sally-Ann test. Gopnik et al. (1994) suggested that an awareness of perceptual misrepresentation might be an important precursor of the understanding of false belief. It was thus conjectured that children who reliably avoided commission errors for the occluded handles would show better performance on the Sally-Ann test than children who drew unrealistically. Among the non-autistic groups, results for the Sally-Ann ToM test were not associated with drawing skills. However, the results for the autistic group seem consistent with Gopnik et al.'s view given that these children were more likely to achieve a realistic depiction of the occluded handles when they passed the Sally-Ann ToM test than when they failed. On the other hand, this association might merely reflect the relations between the understanding of false belief and general cognitive functioning. In the autistic group, success on the ToM measure was reliably greater among the older and more cognitively mature participants.

There was similarly little evidence that children's drawing skills were influenced by their drive for central coherence. Central coherence has been defined as "the everyday tendency to process incoming information in its context – that is, pulling information together for higher level meaning" (Happe, 1999, p. 217). If a person's expectations about the environment distort their perception of reality then it follows that superior drawing ability should be linked with a *weak* drive for central coherence (Pring et al., 1995). In the present investigation, central coherence was measured in the clinical groups using the Block Design test of the WISC. Whereas performance on this test showed positive correlations with the depiction of decorative and contextual details in both the autistic and the Down's syndrome groups, as well as with the ability to avoid commission errors for the occluded handles in the autistic group, these associations did not reach significance. The present findings might indicate that central coherence is predictive of drawing ability only in adults. On the other hand, the Block Design test might not be a sensitive measure of central coherence for young children or participants with low intellectual ability or, alternatively, central coherence might influence subtler aspects of drawing competence than were assessed here such as attention to local detail and the ability to attain an accurate depiction of visual perspective.

Although mental age showed at least some association with drawing ability in the control and autistic groups, this was not true for the Down's syndrome group. Instead, the Down's syndrome group exhibited a significant relation between *chronological* age and accuracy at depicting decorative and contextual information. Indeed, in contrast to predictions, the results of the various skills' tests for the Down's syndrome children showed marginally *negative* correlations with drawing accuracy for the occluded handles. The more able participants were therefore *less* likely to achieve visual realism on this measure. Like the present research, previous investigations have failed to uncover links between mental age and drawing ability among sufferers of Down's syndrome (Clements & Barrett, 1994; Cox & Maynard, 1998; Eames & Cox, 1994; Laws & Lawrence, 2001). Laws and Lawrence (2001) concluded that drawing skills do not develop in the normal way in Down's syndrome, possibly due to the poor motor skills and visual problems that afflict many children with this disorder. While consistent with this conclusion, the present findings nevertheless should not be construed as meaning that drawing skills are unconstrained by intellectual maturity in Down's syndrome. As discussed earlier, the ability to avoid commission errors for the occluded handles was contingent on a relatively high non-verbal age in the Down's syndrome group just as for the control and autistic groups, despite the fact that RCPM scores were not reliably correlated with drawing competence.

3. The effects of functional context on the frequency of commission errors

Davis (1983) noted that young children were less likely to make a commission error when portraying a mug with an occluded handle if the model was paired with another mug for which the handle could be seen. She suggested that children choose to depict the occluded handle only when they are concerned that the model's identity as a mug will otherwise be unclear. Following this line of reasoning, it was predicted that participants in the present study would make fewest commission errors in the cup-and-saucer task (because the presence of the saucer correctly indicates that the object is a teacup) and most errors in the cup-and-flowers task (because the presence of the flowers wrongly suggests that the object is a vase) with an intermediate level of accuracy in the striped mug task (no contextual information). This prediction was not confirmed. Whereas there was marked variation in the incidence of commission errors across the different mug/cup tasks, at least in the developmentally normal and Down's syndrome groups, the results were not wholly in the anticipated direction. Despite the expected improvement in drawing realism from the striped mug to the cup-and-saucer task, the highest levels of drawing accuracy emerged in the cup-and-flowers task. The results thus failed to support the idea that children aimed to expose the *real* identity of the model and, instead, it appears they provided sufficient detail in their drawings to preserve the *impression* of the model's identity suggested by its contextual attributes.

Importantly, whereas there was an obvious context effect for the developmentally normal and Down's syndrome groups it failed to appear for the autistic group. Instead, the autistic children showed no change in their propensity to make commission errors across the various mug/cup tasks. These findings extend the work of Charman and Baron-Cohen (1993) who found that, in contrast to the results reported for non-autistic children (e.g., Light & McEwan, 1987; Littleton & Cox, 1989), their autistic sample showed no improvement in the ability to depict one object partially occluding another when the occluded object was described as 'hiding'. The results of the present investigation suggest that autistic children not only lack sensitivity to social relations crucial to understanding the positioning of the drawing model, they also fail to appreciate the significance of contextual relations that convey information about its intended function.

Charman and Baron-Cohen attributed autistic children's difficulties with the 'hiding' task to their deficits in theory of mind and the understanding of mental state representations. Possibly, inattention to functional context on the part of the autistic group in the present study could be explained in the same way. That is, whereas the non-autistic children might have been concerned with how their drawing would be interpreted by another person and motivated to depict the model in such a way as to provide logical consistency with its surrounding attributes, lack of a well-developed conception of mind in the autistic group could have meant they failed to consider the viewpoint of a naïve observer. They therefore neglected to modify their drawing strategy for the mug/cup across its different presentation formats. To explore this possibility, results were compared for autistic children who passed versus failed the Sally-Ann test of the understanding of false belief. This analysis failed to uncover a context effect in either group and, thus, there was no evidence that context sensitivity was largely confined children with a better developed theory of mind. Consistent with this conclusion, a robust context effect emerged in both non-autistic groups irrespective of their performance on the Sally-Ann test. Additional analyses found that the context effect held up for both high and low scoring non-autistic children on the BPVS and RCPM tests but was lacking in the autistic children regardless of their verbal and non-verbal capabilities.

Alternatively, sensitivity to context might depend on a strong drive for central coherence. Whereas strong coherence could produce an integrated perception of the model and surrounding attributes, thus highlighting the model's function, weak coherence might result in inattention to contextual information. Although such reasoning accords with claims that autistic individuals have a diminished capacity for perceptual integration (e.g., Happe, 1996), however, it was not supported by the data. When the autistic sample was split into high versus low achieving groups in terms of Block Design scores, there was no evidence of greater sensitivity to context among the poor performers. Similarly, the autistic group did not appear to lack central coherence in the sense of failing to link complex visual input with relevant prior knowledge. If this had been the case then they should not have made any commission errors for the occluded handles irrespective of the model's context. On the other hand, it could be argued that the autistic group showed an *attenuated* effect of prior knowledge (e.g., Mitchell & Ropar, 2003). According to this line of reasoning, they showed normal access to meaning when confronted with the cup-and-saucer but impaired access when confronted with either the mug or the vase.

Another possible explanation of context insensitivity in the autistic group is suggested by claims that individuals with autism experience enhanced discrimination and, thus, diminished generalization (e.g., Plaisted, 2001). Enhanced discrimination of examples during concept formation might mean that autistic individuals show a steeper than normal typicality gradient for their semantic categories. This being the case, while responding in the usual way to highly typical instances (e.g., a cup and saucer as an instance of the 'cup' category) they might be less likely to accept as category members those instances more distant from the prototype (e.g., a striped mug as an instance of the 'mug' category or a cup as an instance of the 'vase' category).

Finally, the results also seem compatible with the idea that autism is characterized by deficits in deep as opposed to shallow processing (e.g., Mottron & Burack, 2001). Sensitivity to contextual attributes might require deep processing in the sense of connecting different aspects of knowledge, consistent with suggestions that conceptual behaviour requires memory integration (Barsalou, Simmons, Barbey, & Wilson, 2003).

This idea also accords with recent evidence of deficient conceptual integration in autism. Although evidence favouring a central coherence deficit in autism has largely been derived from perceptual procedures, some researchers have extended the concept of weak coherence to conceptual tasks. Joliffe & Baron-Cohen (2001) found that, relative to non-autistic controls, normally intelligent adults with either autism or Asperger syndrome exhibited deficits both in integrating sets of lie drawings to create a coherent larger picture and in noticing incongruent objects within meaningful scenes. They therefore concluded that weak coherence afflicts *both* perceptual and conceptual processing in autism.

Recent theorizing by Brock, Brown, Boucher, & Rippon (2002) agrees with this view. Brock et al. proposed a new version of the weak central coherence account, namely, the temporal binding deficit hypothesis of autism, which imputes autistic symptoms to a reduction in the integration of specialized local neural networks in the brain. Their framework suggests there are differences between autism sufferers in the extent of their integration deficit, with low-functioning individuals showing a pervasive deficit across both conceptual and visuoperceptual processing and high-functioning individuals having difficulties only with higher-level conceptual processing involving the coordinated action of multiple brain regions. Such arguments mean it might be premature to dismiss the possibility of a link between central coherence and children's sensitivity to functional context during drawing. Whether a context effect emerges might reflect children's central coherence at the *conceptual* level whereas performance on the Block Design test might reflect their central coherence at the *perceptual* level.

Importantly, the present finding of context insensitivity in the drawing performance of the autistic group provides a good example of an aberrant *pattern* of results that is desirable in autism research. Mitchell and Ropar (2003) argued that evidence that autistic and non-autistic groups differ in their performance on a particular test could be attributed to unequal matching. In contrast, they claimed that a difference between groups in the pattern of performance across conditions would provide significant evidence of behaviour that is categorically autistic.

4. The Draw-A-Person test

As an additional measure of drawing maturity, participants in the present investigation completed the Goodenough-Harris Draw-A-Person test (Harris, 1964). Interest focused on the relations between Draw-A-Person achievements and intellectual maturity, and between Draw-A-Person achievements and drawing realism in the mug, teapot, and cup tasks. Similar to the findings of Watanabe et al. (2002), Draw-a-Person age-equivalent scores in the autistic group lagged behind their chronological age but exceeded their verbal age. In contrast, results for the control and Down's syndrome groups were congruent with *both* verbal and non-verbal ability. These findings support the validity of the Draw-A-Person test as a measure of cognitive functioning during childhood. Draw-a-Person scores were reliably correlated with BPVS performance in all groups and they also showed a reliable correlation with RCPM performance in the Down's syndrome group. It is unclear why BPVS scores were the best predictor of Draw-A-Person outcomes but, as mentioned earlier, links between verbal skills and drawing competence might reflect the contribution of language to memory and executive function during childhood. The strong association between Draw-A-Person scores and intellectual maturity for the Down's syndrome children might be considered surprising given that results for the object-drawing tasks were not similarly predicted by cognitive skills in this particular group. Also, an investigation by Cox and Maynard (1998) found no significant correlation between Draw-A-Person results and verbal maturity in Down's syndrome children. Possibly, this discrepancy reflects the fact that participants in the present study were asked to draw a self-portrait from memory whereas participants in Cox and Maynard's study were asked to draw an unknown person from imagination or from a model. Requesting children to produce a self portrait might have motivated them to try harder in the Draw-A-Person test, making it easier for them to achieve their potential.

Draw-A-Person scores showed a reliable, positive correlation with the object-drawing scores only in the autistic group and only in relation to children's ability to avoid commission errors for the occluded handles. Importantly, this relation held up even when the effects of chronological age were controlled for. This could indicate that the autistic group tended to apply the same strategies across a variety of drawing tasks. In contrast, the non-autistic groups might have treated the self-portrait differently to their other drawings. For example, when drawing a self portrait children might have been motivated to produce an accurate portrayal and they might have worked hard at examining their memories to generate realistic details. This possibility could be evaluated in future research by comparing the performance of autistic versus non-autistic children on the

Draw-A-Person test given instructions to produce a self-portrait from memory versus to draw an unfamiliar person presented as a model.

5. Matched group analyses

As expected, the groups exhibited markedly different cognitive profiles. Given these differences, additional analyses were carried out that compared drawing skills in the developmentally normal and autistic groups using a subset of participants who were matched closely on intellectual maturity. The first set of analyses involved participants matched for verbal age (i.e., BPVS scores) and the second set of analyses involved participants matched for non-verbal age (i.e., RCPM scores).

The initial analyses confirmed the absence of precocious drawing development among the autistic sample, with the groups failing to differ significantly in any aspect of their drawing competence. In contrast, matching the groups on non-verbal ability showed that the autistic children significantly outperformed the developmentally normal children at depicting the pattern on the teapot. This result reflects the negative relation between verbal age and accuracy at depicting the pattern among the developmentally normal children. The process of matching the groups according to their RCPM scores necessarily involved the selection of high-scoring participants from the control group on both verbal and non-verbal capabilities. It therefore produced a sample of children who performed very poorly on this measure. The matched group analyses additionally confirmed that a task-dependent shift in the frequency of commission errors was evident only for the non-autistic group. As for the wider sample, the autistic group showed a similar incidence of such errors across the striped mug task, the cup-and-saucer task, and the cup-and-flowers task. These findings provide strong evidence for a real difference in sensitivity to contextual information between autistic and non-autistic children.

6. Analyses of gender differences in drawing performance

Because the autistic sample was predominantly male, consistent with the general population of autism sufferers, results in the control group were considered separately for each gender. These analyses provided no support for the idea that the aspects of drawing performance on which the autistic group deviated from the non-autistic groups could have arisen as a function of differences in drawing development between boys and girls. There was no gender difference in any aspect of drawing realism and, more importantly, that boys behaved similarly to girls in their responses to both the pattern on the teapot and contextual attributes in the mug/cup drawing tasks. That is, unlike the autistic group, boys in the control group showed a reliable negative correlation between their BPVS scores and their ability to achieve an accurate depiction of the pattern and they showed a reliable decrease in commission errors for the occluded handle from the striped mug task, to the cup-and-saucer task, to the cup-and-flowers task. Nevertheless, the present findings do not rule out the possibility that the typical gender imbalance in autism might produce differences between autistic and non-autistic groups given drawing topics that allow for the expression of sex differences. Research has shown that, among normally developing children, boys and girls show different drawing preferences and styles (review by Cox, 1992).

7. Conclusions and directions for future research

In conclusion, the present investigation contributed to knowledge about drawing development in autistic versus non-autistic children in three main ways. First, using novel drawing tasks that involved models with both generic and non-generic features it confirmed conclusions from previous research that autistic children without any exceptional artistic talent show no precocious drawing skills. Second, it produced important evidence that autistic children differ from non-autistic children in their sensitivity to the contextual attributes of the drawing model. The developmentally normal and Down's syndrome children showed a reliable shift in their propensity to make a commission error for the occluded handle of a mug/cup across different functional contexts but this effect was lacking for the autistic children. Third, for *both* autistic and non-autistic children it was found that different measures of intellectual maturity predicted different aspects of drawing ability. Children's ability to avoid commission errors for occluded handles depended on reasonably advanced non-verbal capabilities but the realism with which they depicted decorative and contextual details, as well as their self portraits, depended more on their age and verbal skills.

These findings suggest a number of avenues for future research. One obvious way forward is to attempt to replicate the present outcomes using a greater variety of drawing models. This would enable it to be seen, for example, whether the negative relation between verbal ability and the depiction of the pattern on the teapot shown by the control children holds up for different objects with different kinds of decorative features. Similarly, given there was little association between drawing competence and the understanding of false belief in the present study, future research could provide a more rigorous test of this hypothesized link using additional false belief tasks. It might also be beneficial to carry out similar tests with slightly younger children in case any relations between theory-of-mind and drawing skills are detectable only at low levels of intellectual maturity.

It would also be useful to administer standardised measures of motor ability in future investigations of the present kind. As already noted, Down's syndrome is characterised by motor problems that are likely to impair drawing performance (Laws & Lawrence, 2001). One difficulty with evaluating drawing development in autism is that the task of obtaining participants who are capable of understanding the test instructions requires selecting a sample that is advanced in chronological age relative to the non-autistic comparison group. Whereas the present study produced no evidence that drawing realism was superior in the autistic sample, which could potentially be explained by better developed motor skills in older participants, it would be of interest to separate the relations between chronological age and different aspects of drawing performance into the contributions of motor ability versus knowledge and experience.

The present work could additionally be extended by evaluating context sensitivity in autistic and non-autistic children using alternative contextual manipulations designed to uncover the bases for shifts in the frequency of commission errors. For example, the idea that semantic categories have a steeper typicality gradient for autistic than non-autistic children could be tested by assessing how readily each group makes commission errors for the occluded handles of mugs with high versus low typicality. If autistic children find it harder to generalize from the category prototype then they might be less likely than non-autistic children to incorrectly depict the handle given a highly unusual example of a mug. Alternatively, the extent to which children reason about another person's interpretation of their drawing could be estimated by presenting two examples of the model placed in different orientations (e.g., Davis, 1983). Although the latter approach was adopted by Eames and Cox (1994), uniformly accurate performance by the control group in their study made it difficult to interpret the lack of a context effect in the autistic group.

Autistic children could also be tested for their attention to context in object identification procedures. Studies of categorization by non-autistic adults have indicated that the semantic representations of objects include extensive contextual information. For example, people are quicker to identify objects when they are embedded in appropriate scenes (such as a chair in the context of a dining room) than when they are presented in isolation (Biederman, 1981), a finding that has given rise to the notion of *situated concepts* (Barsalou, 2002). It would be of interest to know whether autistic children exhibit equivalent contextual priming to non-autistic children and, if not, whether their deficits are predicted by their performance on tests of perceptual or conceptual central coherence.

For both autistic and non-autistic children, future research could explore more thoroughly the reasons why children make commission errors for occluded features of the drawing model. As discussed earlier, false depictions of the occluded handle of a mug or cup have been attributed to the inefficient control of visual attention (Sutton & Rose, 1998). This idea can account for the link between RCPM scores and the ability to avoid such depictions that was observed in the present study. Alternatively, children might incorrectly portray an occluded handle because their performance is constrained by automatic processes serving object recognition. Hodgson (2002) suggested that the characteristic view of an object (i.e., as determined by its important generic features) becomes preferentially represented in neural circuits. He speculated that it is easier for young children to show intellectual realism than visual realism because they access the neuronal network mediating a canonical representation more quickly than they access a less tightly knit network mediating unusual views. Hodgson additionally postulated that, because the canonical representation comes to mind first, children need to inhibit the canonical view to achieve drawing realism. If this suggestion is correct then the ability to avoid commission errors should be associated with inhibitory control, even after controlling for other aspects of children's intellectual maturity. This possibility could be checked in future research by augmenting the present battery of cognitive skills with measures of executive function, particularly inhibition.

The idea that commission errors can be understood in terms of the basic processes supporting object recognition also predicts that children will be unlikely to succumb to such errors if the occluded features of the model are not generic. At least some research indicates that children fail to treat all occluded details with the same importance during drawing. Krascum, Tregenza, and Whitehead (1996) confronted 8-year-olds with novel objects that had perceptually salient features. Some children received information about the functions of the objects whereas other children simply handled and examined the objects without learning their functions. When children were later asked to produce a view-specific drawing of the objects, positioned such that the salient features were occluded, those who were aware of the feature functions were more likely to make commission errors. In the present investigation, handles were always occluded whereas decorative and contextual attributes were visible from the child's perspective. Future studies along the same lines could examine whether children make commission errors for occluded features that are merely decorative and which aspects of intellectual maturity, if any, predict children's ability to avoid errors of this type. Such studies should greatly enhance our understanding of the shift from intellectual to visual realism during early childhood and possible differences in the drawing development of autistic and non-autistic children.

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Appendices

APPENDIX A. The information and consent forms

INFORMATION SHEET

Drawing ability in autistic and non-autistic children and its relation to measures of cognitive functioning

Aims:

This study aims to compare drawings (objects and people) by autistic children and non-autistic children to see whether, and in what respects, they might differ. It will also investigate whether children's drawing performance is related to their verbal and non-verbal abilities.

Method:

First, children will be given a pre-test that assesses their understanding about view-specificity in pictures. Initially they will be shown a teddy, and the teddy will be placed on a table in front of them and turned so that it is facing away from them. Children will be told that they are going to see two pictures of the teddy, and that they should point to the picture showing the teddy *as it looks from where they are sitting*. They will then see two pictures, one showing the teddy from the front and the other showing the teddy from the back, and they will be asked to select the appropriate picture. Next, they will be shown a doll and the same task will be repeated. If a child fails to select the correct picture on both occasions then they will not be tested further.

Second, the children who pass the pre-test will be assessed for their verbal and non-verbal intelligence. Verbal intelligence will be measured with the British Picture Vocabulary Scale. This test involves asking children to identify a series of pictures, and takes from 5 to 8 minutes to complete. Non-verbal intelligence will be measured with Raven's Coloured Progressive Matrices and with the Block Designs Patterns Task. In the Raven's Coloured Progressive Matrices test, children see a series of patterns with a piece missing. They are asked to select a piece (from a set of six) to make the large pattern complete. There are 36 patterns and the task takes about 20 minutes to complete. In the Block Design Patterns test, children are given a set of patterned blocks and they are asked to place the blocks together such that the upper surface of the arrangement displays the same pattern as shown in a picture. This task takes about 10 minutes to complete.

Third, children will be given a test to assess the extent to which they understand that other people can have different knowledge and mental viewpoints from their own. They will be shown two dolls called Sally and Ann. Sally has a marble which she keeps in a box. When Sally goes out of the room, Ann takes the marble out of Sally's box and places it in her own basket. Children are asked where Sally will look for her marble when she comes back.

Finally, children will be asked to make a series of five drawings in random order.

i. Children will be shown a striped mug and asked to say what it is. After they have inspected it from all angles, the mug will be placed on a table in front of them and positioned so that its handle is hidden from view. Children will be asked to "draw the mug as it looks to you from where you are sitting".

ii. Children will be shown two teapots. One teapot will have a green triangle above the spout and the other will have a green circle above the spout. The experimenter will take one teapot and position it on the table such that both the spout and the decorative feature are hidden from view. Children will then be asked to draw the teapot as it looks from where they are sitting.

iii. Children will be shown a teacup, and it will be placed on a saucer and positioned so that its handle is hidden from view. Children will then be asked to draw the teacup as it looks from where they are sitting.

iv. The teacup will have a flower placed inside it so that it appears to be a vase. Once again, the teacup will be positioned so that its handle is hidden from view and children will be asked to draw the teacup as it looks from where they are sitting.

v. Children will be asked to produce a self-portrait.

It is anticipated that, in most cases, the pre-test and the various tests of cognitive ability will be administered in one session and that the drawing tasks will be administered in a second session. However, children will be allowed to attempt the different tests at their own pace and they will not be pressured to continue with the tests if they do not wish to do so. Thus, the speed of data collection will be adapted to each child's individual preference.

Consent Form for the Drawing Study

I.., being the parent or legal guardian

of..., consent / do not consent (delete whichever is inapplicable)

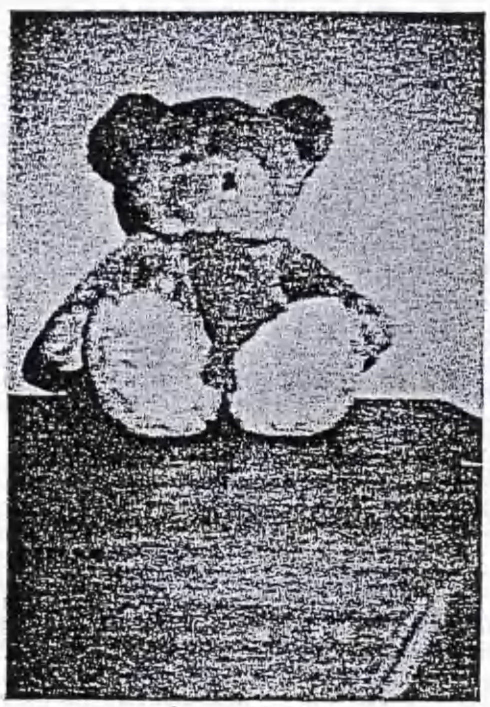
to my child (as named above) being tested in the drawing study.

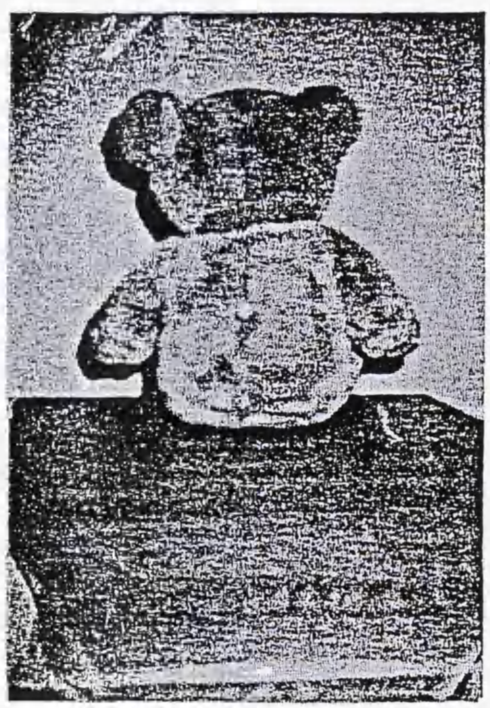
....
Signature of Parent / Guardian

This consent is given on the understanding that the conditions in relation to preserving my child's anonymity, as outlined in the accompanying letter, are honoured.

....
Signature of Parent / Guardian

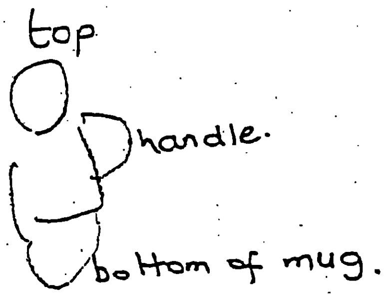
APPENDIX B. The pre-test photographs

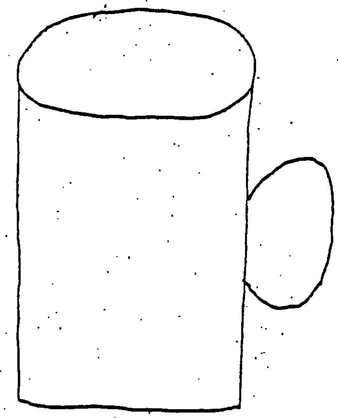




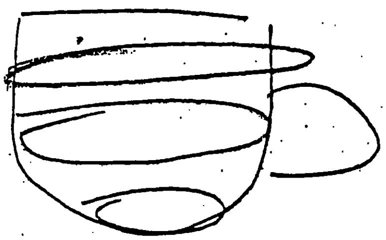
APPENDIX C. Examples of children's drawings

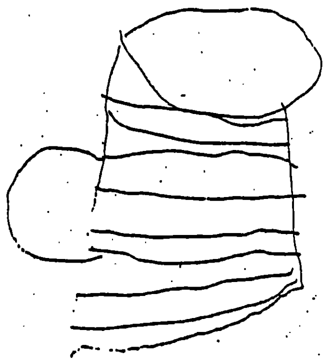
Striped mug: symbolism



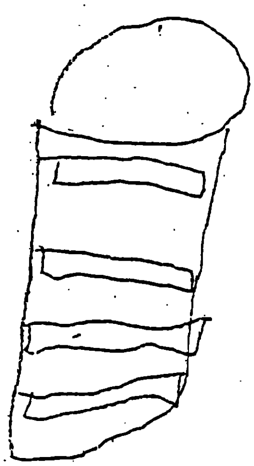


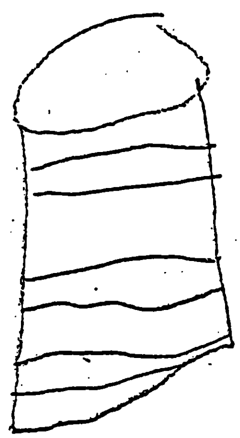
Striped mug: intellectual realism



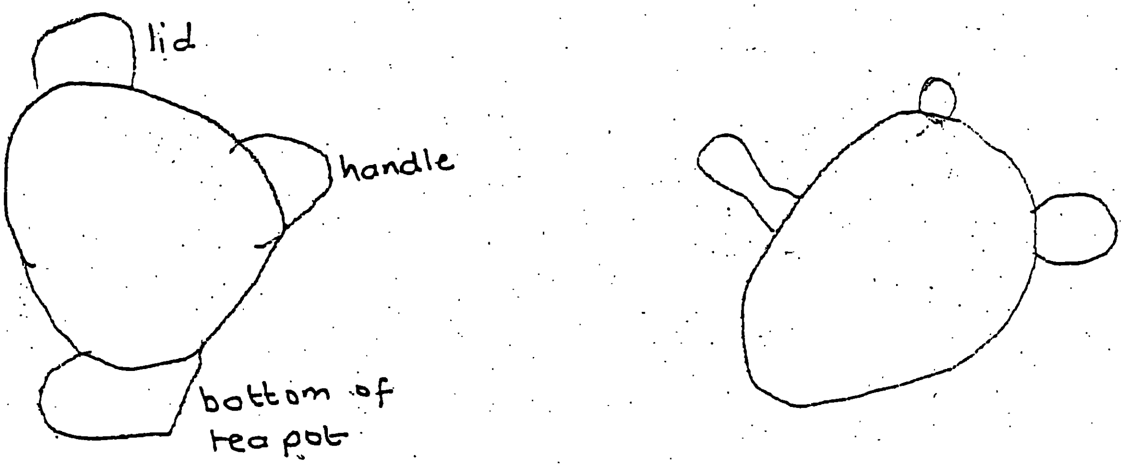


Striped mug: visual realism

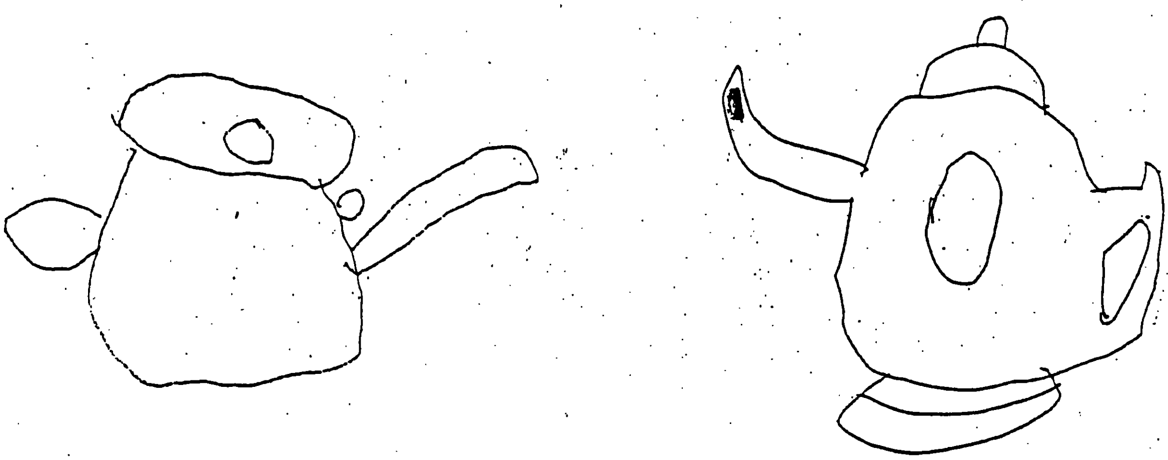




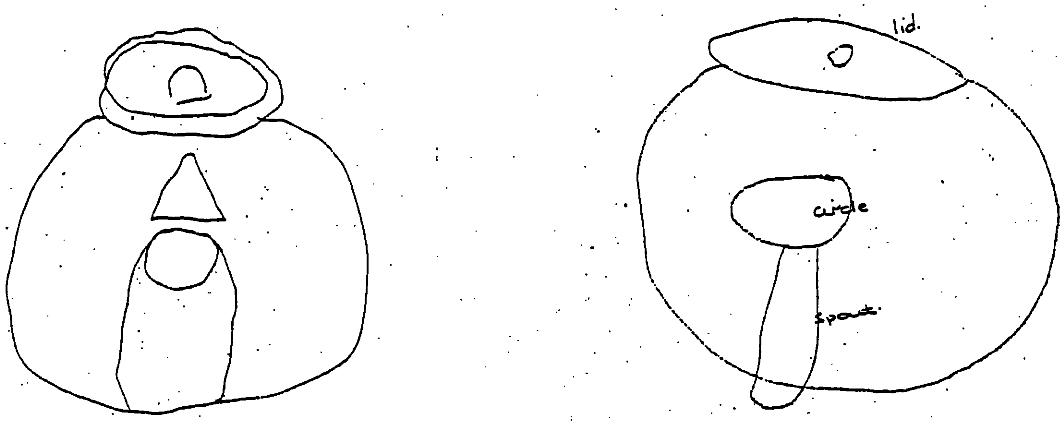
Teapot: symbolism



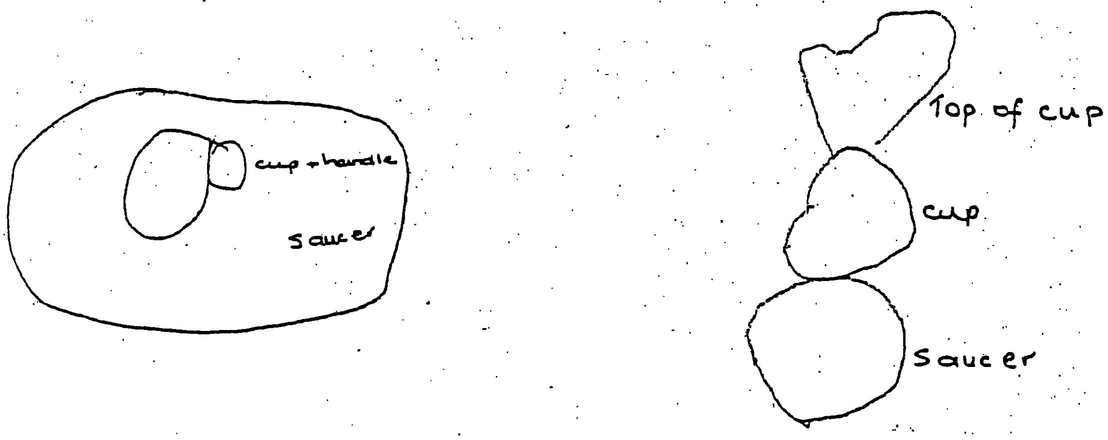
Teapot: intellectual realism



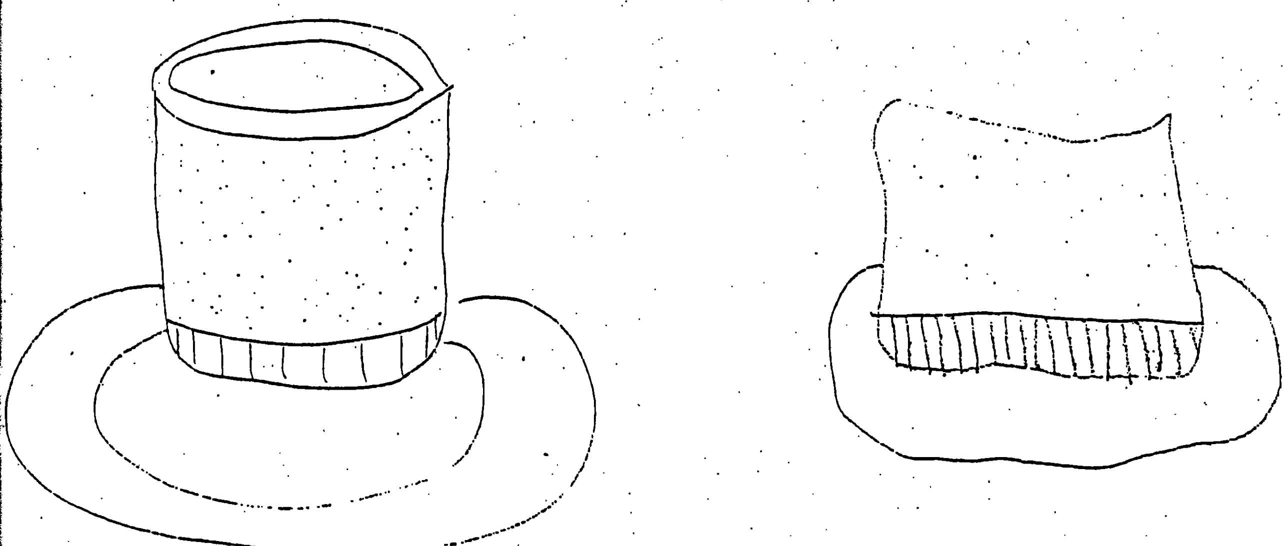
Teapot: visual realism



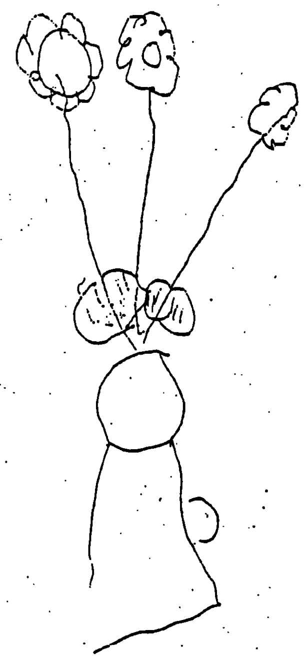
Cup-and-saucer: symbolism / intellectual realism

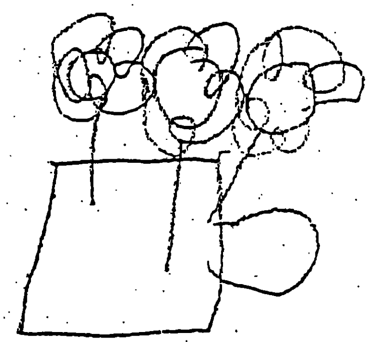


Cup-and-saucer: visual realism

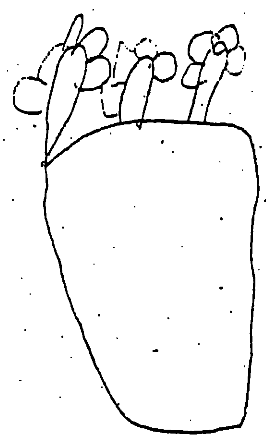


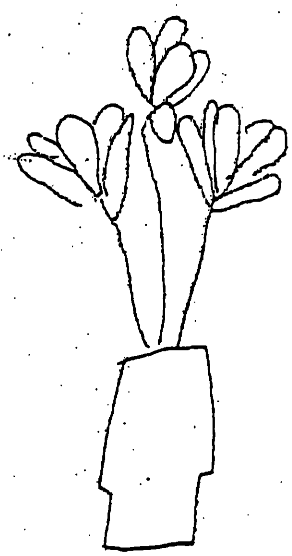
Cup-and-flowers: symbolism / intellectual realism



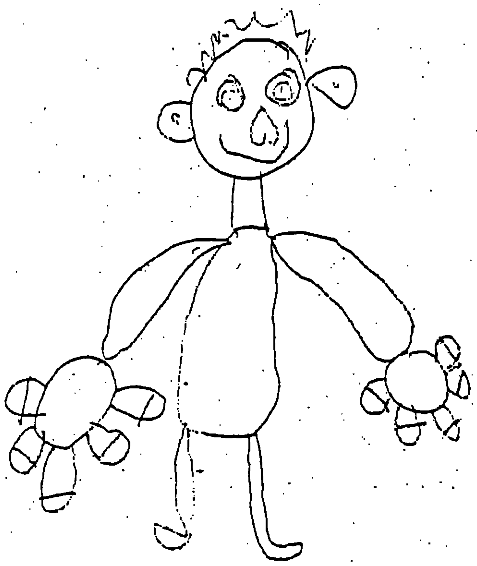


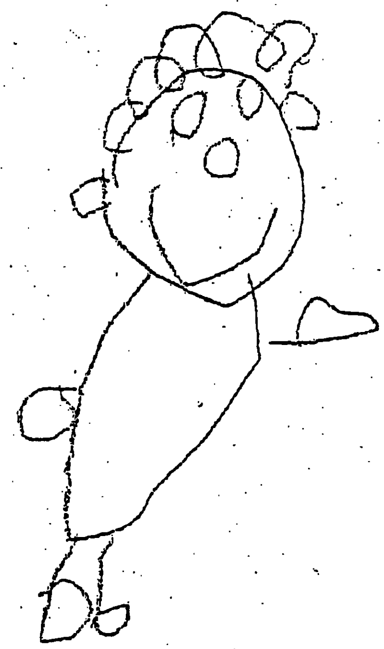
Cup-and-flowers: visual realism



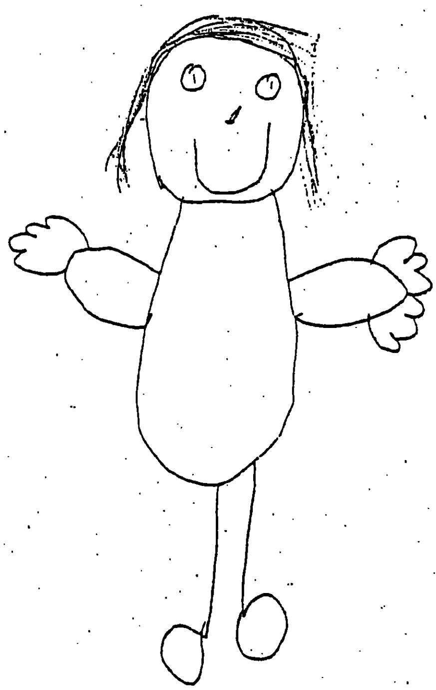


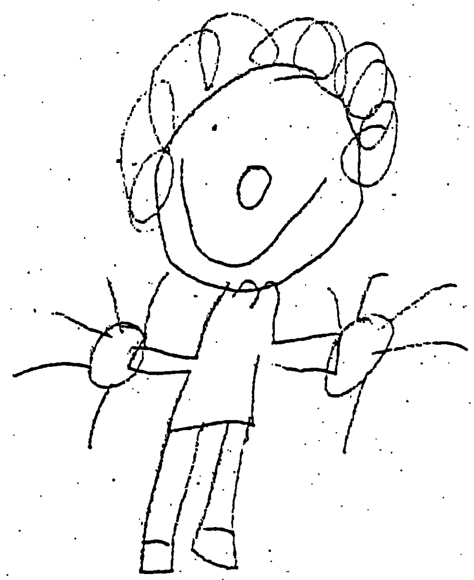
Draw-A-Man:





Draw-A-Woman:





<u>APPENDIX D</u>. Scoring criteria for the depiction of decorative and contextual details

The stripes on the mug:

0 = missing

1 = separate from the mug

2 = depicted inside the outline of mug

The pattern on the teapot:

0 = missing

1 = outside the teapot

2 = depicted inside the outline of teapot

The saucer in the cup-and-saucer task:

0 = missing

1 = separate from cup

2 = around cup

3 = touching cup but not occluded

4 = touching cup and partly occluded

The flowers in the cup-and-flowers task:

0 = missing

1 = separate from cup

2 = in cup, but stalks or water visible

3 = in cup, contents of cup occluded

APPENDIX E. Scoring criteria for the Draw-A-Person Test

Short Scoring Guide

Woman Point Scale

1. Head present
2. Neck present
3. Neck two dimensions
4. Eyes present
5. Eye detail : brow or lashes
6. Eye detail : pupil
7. Eye detail : proportion
8. Cheeks
9. Nose present
10. Nose:two dimensions
11. Bridge of nose
12. Nostrils shown
13. Mouth present
14. Lips, two dimensions
15."Cosmetic lips"
16. Both nose and lips in two dimensions.
17. Both chin and forehead shown
18. Line of jaw indicated
19. Hair 1
20. Hair 11
21. Hair 111
22. Hair 1V
23. Necklace or earrings
24. Arm present
25. Shoulders
26. Arms at side (or engaged in activity or behind back)
27. Elbow joint shown
28. Fingers present
29. Correct numbers of fingers shown
30. Detail of fingers correct
31. Opposition of thumb shown
32. Hands present
33. Legs present
34. Hip
35. Feet 1 :any indication
36. Feet 11:proportion
37. Feet 111:detail
38. Shoe 1 "Feminine"
39. Shoe 11 :Style
40. Placement of feet appropriate to figure
41. Attachment of arms and legs 1
42. Attachment of arms and legs 11
43. Clothing indicated
44. Sleeve 1
45. Sleeve 11
46. Neckline 1
47. Neckline 11:collar
48. Waist 1
49. Waist 11
50. Skirt "modeled" to indicate pleats or draping.
51. No transparencies in the picture
52. Garb feminine
53. Garb complete without incongruities
54. Garb a definite "type"
55. Trunk present
56. Trunk in proportion, two dimensions
57. Head-trunk proportion
58. Head: proportion
59. Limbs: proportion
60. Arms in proportion to trunk
61. Location of waist
62. Dress area
63. Motor coordination: junctures
64. Motor coordination: lines
65. Superior motor coordination
66. Directed lines and form: head outline
67 .Directed lines and form: breast
68. Directed lines and form: hip contour
69. Directed lines and form: arms taper
70.Directed lines and form: calf of leg
71. Directed lines and form: facial features

Short Scoring Guide

Man Point Scale.

1. Head present
2. Neck present
3. Neck, two dimensions
4. Eyes present
5. Eye detail : brow or lashes
6. Eye detail: pupil
7. Eye detail: proportion
8. Eye detail : glance
9. Nose present
10. Nose.two dimensions
11 .Mouth present
12. Lips: two dimensions
13. Both nose and lips in two dimensions
14. Both chin and forehead shown
15. Projection of chin shown, chin clearly differentiated from lower lip.
16. Line of jaw indicated
17. Bridge of nose
18. Hair 1
19. Hair 11
20. Hair 111
21. Hair 1V
22. Ears present
23. Ears present: proportion and position
24. Fingers present
25. Correct number of fingers shown
26. Detail of fingers correct
27. Opposition of thumb shown
28. Hands present
29. Wrist or ankle shown
30. Arms present
31. Shoulders 1
32. Shoulders 11
33. Arms at side or engaged in activity
34. Elbow joint shown
35. Legs present
36. Hip 1 (crotch)
37. Hip 11
38. Knee joint shown
39. Feet 1:any indication
40. Feet 11:proportion
41. Feet 111:heel
42. Feet 1V:perspective
43. Feet V: detail
44. Attachment of arms and legs1
45. Attachment of arms and legs11
46. Trunk present
47. Trunk in proportion, two dimensions
48. Proportion: head 1
49. Proportion: head 11
50. Proportion: face
51. Proportion: arms 1
52. Proportion: arms 11
53. Proportion: legs
54. Proportion: limbs in two dimensions
55. Clothing 1
56. Clothing 11
57. Clothing 111
58. Clothing 1V
59. Clothing V
60. Profile 1
61. Profile 11
62. Full face
63. Motor coordination: lines
64. Motor coordination: junctures
65. Superior motor coordination
66. Directed lines and form: head outline
67. Directed lines and form: trunk outline
68. Directed lines and form: arms and legs
69. Directed lines and form: facial features
70. "Sketching" technique
71."Modelling" technique
72. Arm movement
73. Leg movement